APPENDIX 2 – AIRPORT TECHNICAL ADVISORY

Subject: Electromagnetic interference (EMI) induced by L-828, SCR Type, Constant Current Regulators (CCRs).

Some airports have experienced excessive levels of EMI which degrades the performance of some of the airport's air navigational systems, i.e. RVRs, glide slope localizers, ATCTS, etc., SCR type, L-828, CCRs, are the likely sources of EMI due to their inherent operating characteristics. The following are some of the cautionary steps that may help decrease EMI and/or its adverse effects in the airport environment.

1. Cables for airfield lighting circuits should not be installed in the same conduit, cable duct or duct bank as control and communication cables.

2. Cables for airfield lighting systems should not be installed such that they cross control and/or communications cables.

3. In some cases, harmonic filters may be installed at the regulator output to reduce the EMI emitted by the CCR. These filters are available from some CCR manufacturers.

4. Spare control and communications cables should be grounded.

5. Inform manufacturers, designers, engineers, etc., about the existing navigational equipment and the potential for interference.

6. Electromagnetic compatibility between new equipment and existing equipment should be a requirement in project contracts. Operational acceptance test(s) may be required to verify compliance.

The FAA is modifying AC 150/5345-10E, *Specification for Constant Current Regulators and Regulator Monitors* to decrease EMI in the airport environment.

For more information contact the FAA Office of Airport Safety and Standards, Engineering and Specification Division at (202)267-8745.

APPENDIX 3 - TERMS & ACRONYMS

AC	Advisory Circular or Alternating Current
Accelerated-stop distance available	The runway plus stopway length declared available and suitable for the acceleration and deceleration of an airplane aborting a takeoff
AIP	Airport Improvement Program
ALD	Available Landing Distance
ALS	Approach Lighting System
ALSF	Approach Lighting System with Sequenced Flashing Lights
ALSF-2	High-Intensity Approach Lighting System (CAT II/III Precision Approach)
ANSI	American National Standards Institute
ASDA	Accelerated-stop distance available
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
CAN/CSA	Canadian Standards Association
CAT I	Facility providing operation down to 200 feet decision height and runway visual range not less than 2600 feet
CAT II	Facility providing operation down to 100 feet decision height and runway visual range not less than 1200 feet
CAT III	Facility providing operation with no decision height limit and along the surface of the runway with external visual reference during final phase of landing and with a runway and runway visual range not less than 600 feet
CCR	Constant Current Regulator
Cd	Candela (a unit of luminous intensity)
CL	Center Line
CTAF	Common Traffic Advisory Frequency
DC	Direct Current
DEB	Direct Earth Burial
Declared Distances	The distances declared available and suitable for satisfying the airplane takeoff run, takeoff distance, accelerate-stop distances, and landing distance requirements. The distances are ASDA, LDA, TORA and TODA.
Displaced Threshold	A threshold that is located at a point on the runway other than the designated beginning of the runway.

DWG	Drawing
E-982	Steady-burning Approach Lights
EMI	Electromagnetic Interference
EMT	Electro-Mechanical Tubing
FAA	Federal Aviation Administration
HIRL	High Intensity Runway Edge Lights
I/O	Input/Output
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IFR	Instrument Flight Rules
ILS	Instrument Landing System
ISO	International Standards Organization
L-850C	Style 3 Low profile semiflush light fixture
L-852D	Taxiway centerline for CAT III
L-852E, F	Runway Guard Light in-pavement
L-852G	Combination Runway Guard
L-852G/S	Combination Runway Guard/Stop Bar Light in-pavement
L-852S	Stop Bar Light in-pavement
L-853	Reflective Markers
L-854	Radio Controller (Pilot Controlled Lights)
L-858R, Y, L, B	Guidance Signs
L-860	Low-Intensity Elevated Light
L-861	Medium-Intensity Elevated Runway/Taxiway Light
L-862	High-Intensity Elevated Runway Edge Light
L-867	Non-load Bearing Base Cans
L-868	Load Bearing Base Cans
L-880/ L-881	Precision Approach Path Indicators (PAPI)
L-884	Land and Hold Short Operations (LAHSO) Power Control Unit (PCU)
LAHSO	Land and Hold Short Operations

Landing Distance Available	The runway length declared available and suitable for a landing aircraft.
LDA	Landing Distance Available
LDIN	Lead-In Lighting System
LHU	Light Housing Unit
LIRL	Low Intensity Runway Edge Lights
MALS	Medium-intensity Approach Lighting System
MALSF	Medium-intensity Approach Lighting System with Sequenced Flashers
MALSR	Medium-intensity Approach Lighting System with Runway Alignment Indicator Lights
MIRL	Medium Intensity Runway Edge Lights
MITL	Medium Intensity Taxiway Lights
MLS	Microwave Landing System
NAS	National Airspace System
NEC	National Electric CodeNational Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Non-precision Approach Runway	Runway with only horizontal guidance available (VOR)
Non-precision Instrument Runway	A runway having an existing instrument approach procedure utilizing air navigation facilities with only horizontal guidance for which a straight-in or side-step non-precision approach procedure has been approved.
NRTL	Nationally Recognized Testing Laboratory
OFZ	Obstacle Free Zone
OSHA	Occupational Safety and Health Administration
PAPI	Precision Approach Path Indicator
PAR	Precision Approach Radar
PCU	Power and Control Unit
PLC	Programmable Logic Controllers
Precision Approach Runway	Full instrument approach procedure and equipment available (ILS or MLS)

Precision Instrument Runway	A runway having an existing instrument approach procedure utilizing air navigation facilities with both horizontal and vertical guidance for which a precision approach procedure has been approved.
PT	Point of Tangency
RCL	Runway Centerline Lighting
REIL	Runway End Identifier Lights
RGL	Runway Guard Lights
ROFA	Runway Object Free Area
RPZ	Runway Protection Zone
RSA	Runway Safety Area
Runway Object Free Area	An area on the ground centered on a runway provided to enhance the safety of aircraft operations by having the area free of objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes.
Runway Protection Zone	An area off the runway end used to enhance the protection of people and property on the ground.
Runway Safety Area	A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or threshold.
RVR	Runway Visual Range
SCR	Silicon Controlled Rectifier
SMGCS	Surface Movement Guidance and Control System
SPDT	Single Pole Double Throw
SSALF	Simplified Short Approach Lighting System with Sequenced Flashers
SSALR	Simplified Short Approach Lighting System Runway Alignment Indicator Lights
SSALS	Simplified Short Approach Lighting System
Takeoff distance available	The TORA plus the length of any remaining runway and/or clearway beyond the far end of the TORA.
Takeoff runway available	The runway length declared available and suitable for the ground run of an airplane taking off.
TDZ	Touchdown Zone
Threshold	A line perpendicular to the runway centerline marking the beginning of the runway surface available for a landing.
TODA	Takeoff distance available
TORA	Takeoff runway available

UL	Underwriter's Laboratory
UPS	Uninterruptible Power Supply
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
VFR	Visual Flight Rules
Visual Runway	Runway with no instrument approach procedure/equipment
VMC	Visual Meteorological Conditions

APPENDIX 4 - BIBLIOGRAPHY

1. AC 00-2, Federal Register, Advisory Circular Checklist and Status of Federal Aviation Regulations (FAR), updated triannually, contains the listing of all current issuances of ACs and changes thereto. It explains the circular numbering system and gives instructions for ordering ACs that are for sale as well as those distributed free of charge. AC 00-2 also gives instructions for ordering the Federal Aviation Regulations.

   a. The following free ACs may be obtained from the Department of Transportation, Publications Section, TAD-443.1, Washington, D.C. 20590:

      (1). AC 70/7460-1, *Obstruction Marking and Lighting.*

      (2). AC 120-29, *Criteria for Approval of Category I and Category II Landing Minima for Approach.*

      (3). AC 120-57, *Surface Movement Guidance and Control System (SMGCS).*

      (4). AC 150/5000-3, *Address List for Regional Airports Divisions and Airports District Offices*.

      (5). AC 150/5000-13, *Announcement of Availability--RTCA Inc., Document RTCA-221, Guidance and Recommended Requirements for Airport Surface Movement Sensors*.

      (6). AC 150/5200-30, *Airport Winter Safety and Operations*.

      (7). AC 150/5300-13, *Airport Design*

      (8). AC 150/5340-1, *Standards for Airport Markings*

      (9). AC 150/5340-9, *Standard Specification for Construction of Airports*

      (10). AC 150/5340-26, *Maintenance of Airport Visual Aid Facilities*

      (11). AC 150/5345-3, *Specification for L-821 Airport Lighting Panel for Remote Control of Airport Lighting*.

      (12). AC 150/5345-5, *Circuit Selector Switch.*

      (13). AC 150/5345-7, *Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits.*

      (14). AC 150/5345-10, *Specification for Constant Current Regulators Regulator Monitors*.

      (15). AC 150/5345-12, *Specification for Airport and Heliport Beacon*.

      (16). AC 150/5345-13, *Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.*

      (17). AC 150/5345-26, *Specification for L-823 Plug and Receptacle, Cable Connectors.*

      (18). AC 150/5345-27, *Specification for Wind Cone Assemblies*.

      (19). AC 150/5345-28, *Precision Approach Path Indicator (PAPI) Systems*

      (20). AC 150/5345-39, *FAA Specification L-853, Runway and Taxiway Retroreflective Markers*.

      (21). AC 150/5345-42, *FAA Specification L-857, Airport Light Bases, Transformer Housing, and Junction Boxes*.

(22). AC 150/5345-43, *Specification for Obstruction Lighting Equipment.*

(23). AC 150/5345-46, *Specification for Runway and Taxiway Light Fixtures.*

(24). AC 150/5345-47, *Isolation Transformers for Airport Lighting Systems.*

(25). AC 150/5345-49, *Specification L-854, Radio Control Equipment.*

(26). AC 150/5345-51, *Specification for Discharge-Type Flasher Equipment.*

(27). AC 150/5345-53, *Airport Lighting Equipment Certification Program.*

(28). AC 150/5345-54, *Specification for L-884 Power and Control Unit for Land and Hold Short Lighting Systems.*

(29). AC 150/5370-2, *Operational Safety on Airports During Construction.*

(30). AC 150/5370-10, *Standards for Specifying Construction of Airports.*

(31). FAA Order 7110.114, *Land and Hold Short Operations (LAHSO).*

(32). FAA Order 6030.20A, *Electrical Power Policy*

(33). FAA Order 6850.2A, *Visual Guidance Lighting Systems*

(34). FAA Order 6950.11, *Reduced Electrical Power Interruptions at FAA Facilities*

(35). FAA Order 6950.27, *Short Circuit Analysis and Protective Device Case Study*

(36). FAA DWG C-6046, *Frangible Coupling Type I and Type IA, Details.*

(37). Engineering Brief #61, *Installation Procedures for Adjustable Light Bases and Extensions*

(38). FAA-E-2083, *Bypass Switch, Engine Generator*

(39). FAA-E-2204, *Diesel Engine Generator Sets, 10kw to 750kw*

(40). FAA-E-2325, *Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights*

(41). 14 CFR part 77, *Objects Affecting Navigable Airspace*

(42). 14 CFR part 139, *Certifications and Operations; Land Airports Serving Certain Air Carriers*

b. The latest issuance of AC 150/5370-10, *Standards for Specifying Construction of Airports*, which can be found in AC 00-2, may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

2. Federal specifications and standards:

a. Federal Specification J-C-145, *Cable, Power, Electrical and Wire, Electrical (Weather-Resistant)*

b. Federal Specification TT-P-28, *Paint, Aluminum, Heat Resisting (1200 Deg. F.)*

c. FED-STD-595*, Colors Used in Government Procurement*

3. ASTMs documents:

   a. ASTM C-892, *Standard Specification for High Temperature Fiber Blanket Thermal Insulation*

   b. ASTM D-3407, *Standard Test Method for Joint Sealants, Hot Poured, for Concrete and Asphalt Pavements*

   c. ASTM Specification A-53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated, Welded and Seamless*

   d. ASTM-A184, *Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement*

   e. ASTM-A704, *Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement*

4. National Fire Protection Association (NFPA) 70, National Electrical Code

5. ANSI/ICEA/IEEE documents:

   a. ANSI/ICEA S-85-625, *Telecommunications Cable Air Core, Polyolefin Insulated, Copper Conductor, Technical Requirements*

   b. ANSI/IEEE C 37.90.1-1989, *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems*

6. Military specifications and standards:

   a. MIL-STD-461, *Requirements for the Control of Electromagnetic Interference Emissions and Suspectibility*

   b. MIL-STD-810, *Department of Defense Test Method for Environmental Engineering Consideration and Laboratory Tests*

7. ISO documents:

   a. ISO 9000, *Quality Management and Quality Assurance Standards*

8. NEMA documents:

   a. NEMA ICS3, *Industrial Control and Systems Factory Built Assemblies*

   b. NEMA ICS1, *Industrial Control and Systems General Requirements*

   c. NEMA ICS2, *Industrial Control and Systems Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC*

9. Other documents:

   a. Airman’s Information Manual

   b. CAN/CSA C22.2 No. 142, *Process Control Equipment*

   c. UL 508, *UL Standard for Safety Industrial Control Equipment Seventeenth Edition*

10. Obtain copies of Rural Electrification Administration (REA) Bulletin 345-14, *Specification PE-23 for Telephone Cables for-Direct Burial*, and REA Bulletin 345-67, *Specification PE-39 for Filled Telephone Cables*, from U.S. Department of Agriculture, Rural Electrification Administration, Information Services Division, Washington, D.C. 20250.

11. Obtain copies of Military Specification MIL-T-27535 (ASG), *Transformer Power, Isolation: Series Circuit, Airport Lighting General Specification for*, from Commanding Officer, Naval Supply Depot, 5901 Tabor Avenue, Philadelphia, Pennsylvania 19120, Attention: Code CDS.

12. Obtain copies of Specification FAA-E-2373, *Adhesive Compound, Two-Component for Sealing Wire in Flexible Pavements*, from Federal Aviation Administration, Configuration Control Branch, AAF-110, 800 Independence Avenue, S.W., Washington, D.C. 20591.

13. IPCEA Publications 5-66-524, *Cross-linked-thermosetting-polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy*, and 5-19-81, *Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy*, may be obtained from the National Electrical Manufacturers Association, 155 East 44th Street, New York, New York 10017.

APPENDIX 5 – TYPICAL INSTALLATION DRAWINGS FOR AIRPORT LIGHTING EQUIPMENT

The following drawings depict typical installation methods for various types of airport lighting equipment and are acceptable for use on projects funded under the AIP. However, the drawings may need to be revised to accommodate local site conditions and/or special requirements.

A5-1. Drawing Details

A5-1.1 Sheet 1

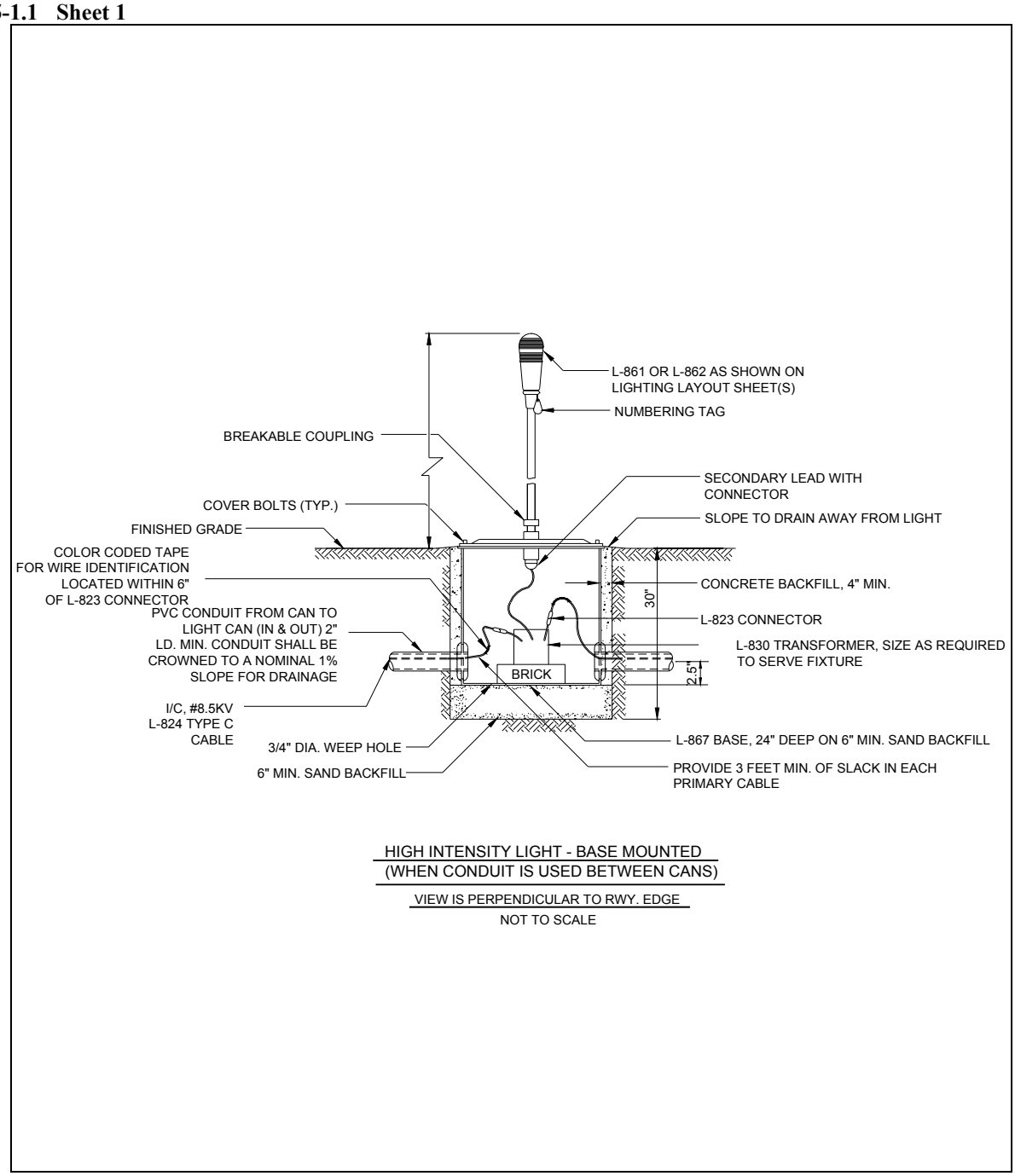


Figure 114 Typical Standard Details for Runway & Taxiway Edge Lights – GL-600 Sheet 1A – High Intensity Light – Base Mounted

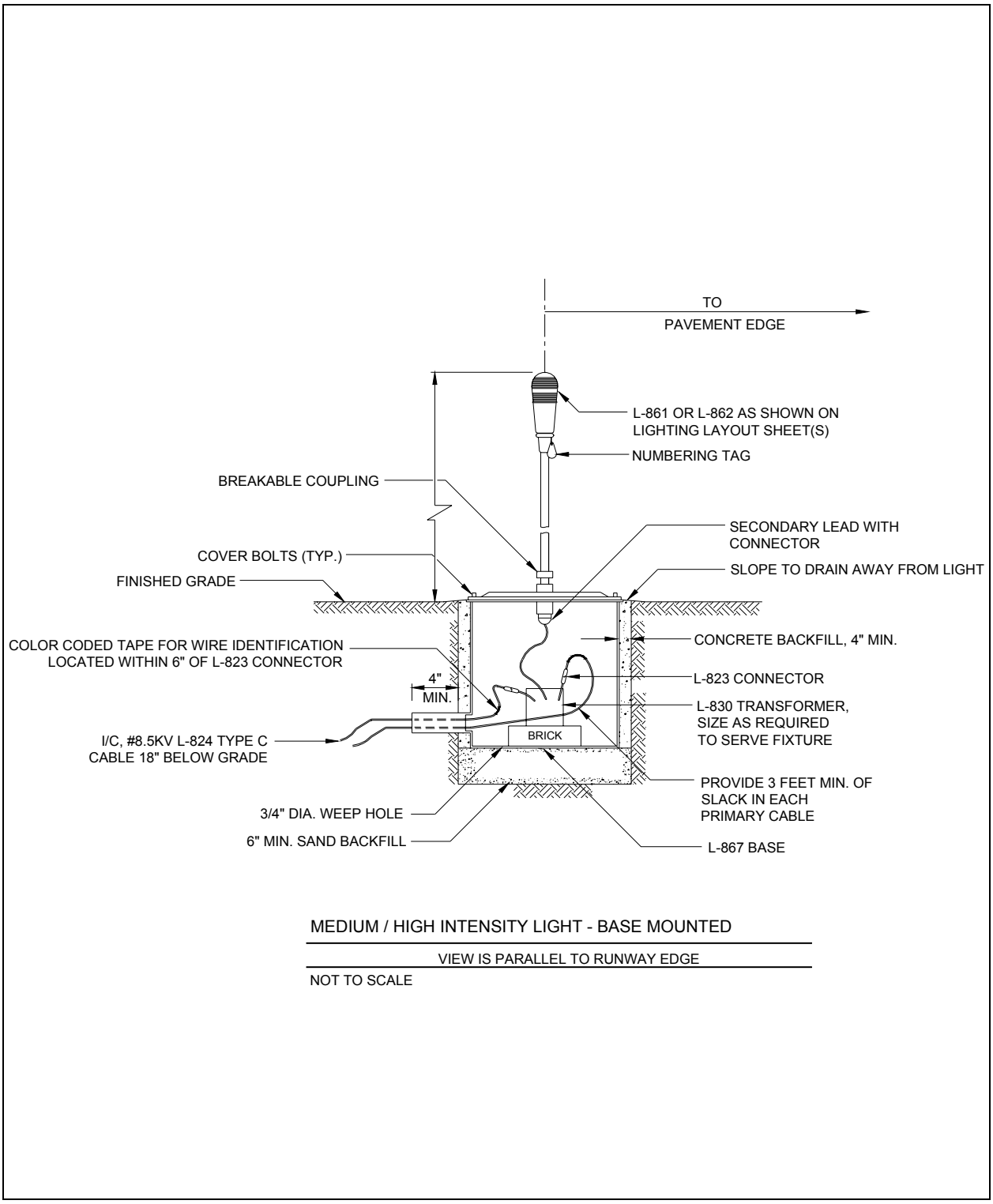


Figure 115 Typical Standard Details for Runway & Taxiway Edge Lights – GL-600 Sheet 1B – Medium / High Intensity Light – Base Mounted

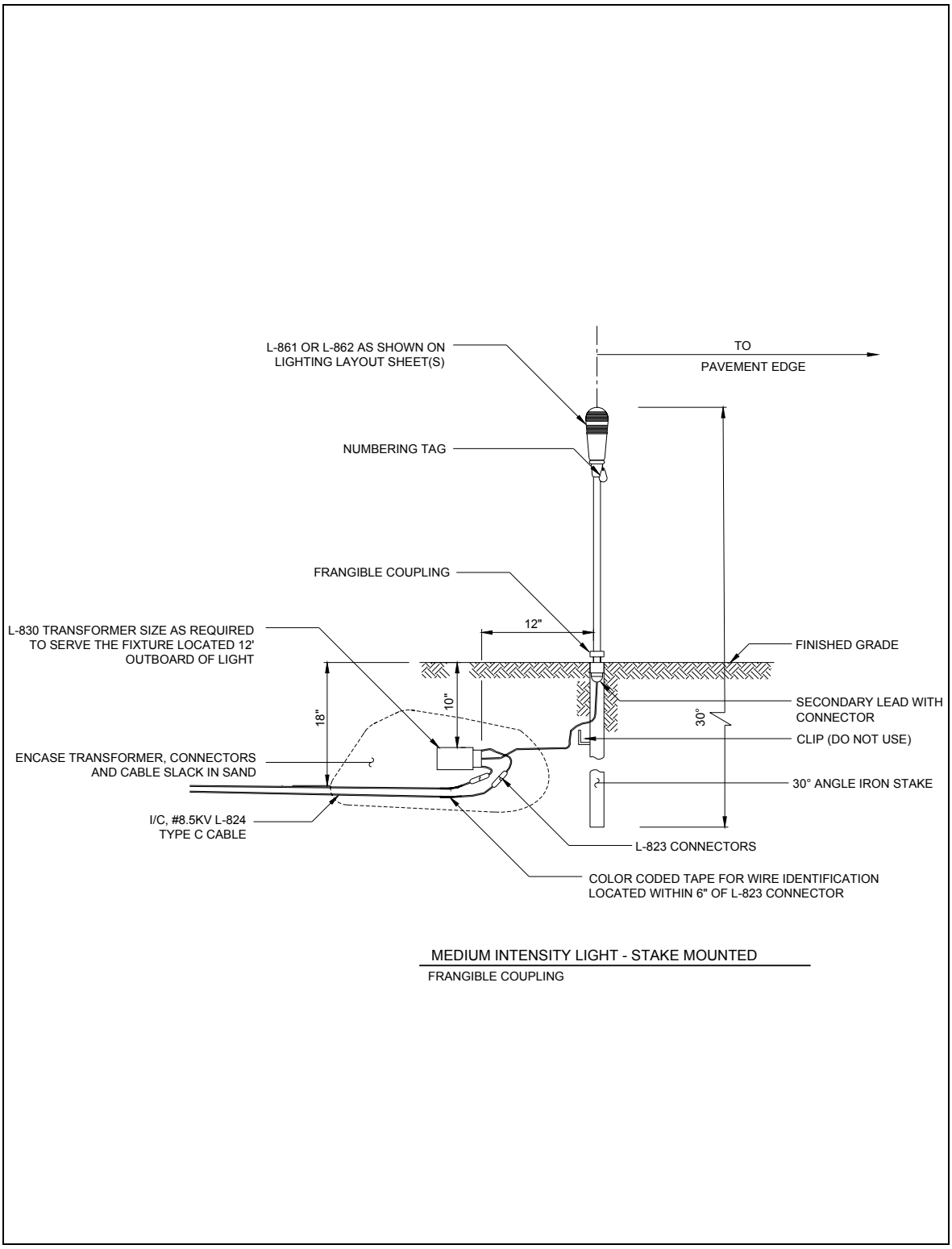


Figure 116 Typical Standard Details for Runway & Taxiway Edge Lights – GL-600 Sheet 1C – Medium Intensity Light – Stake Mounted

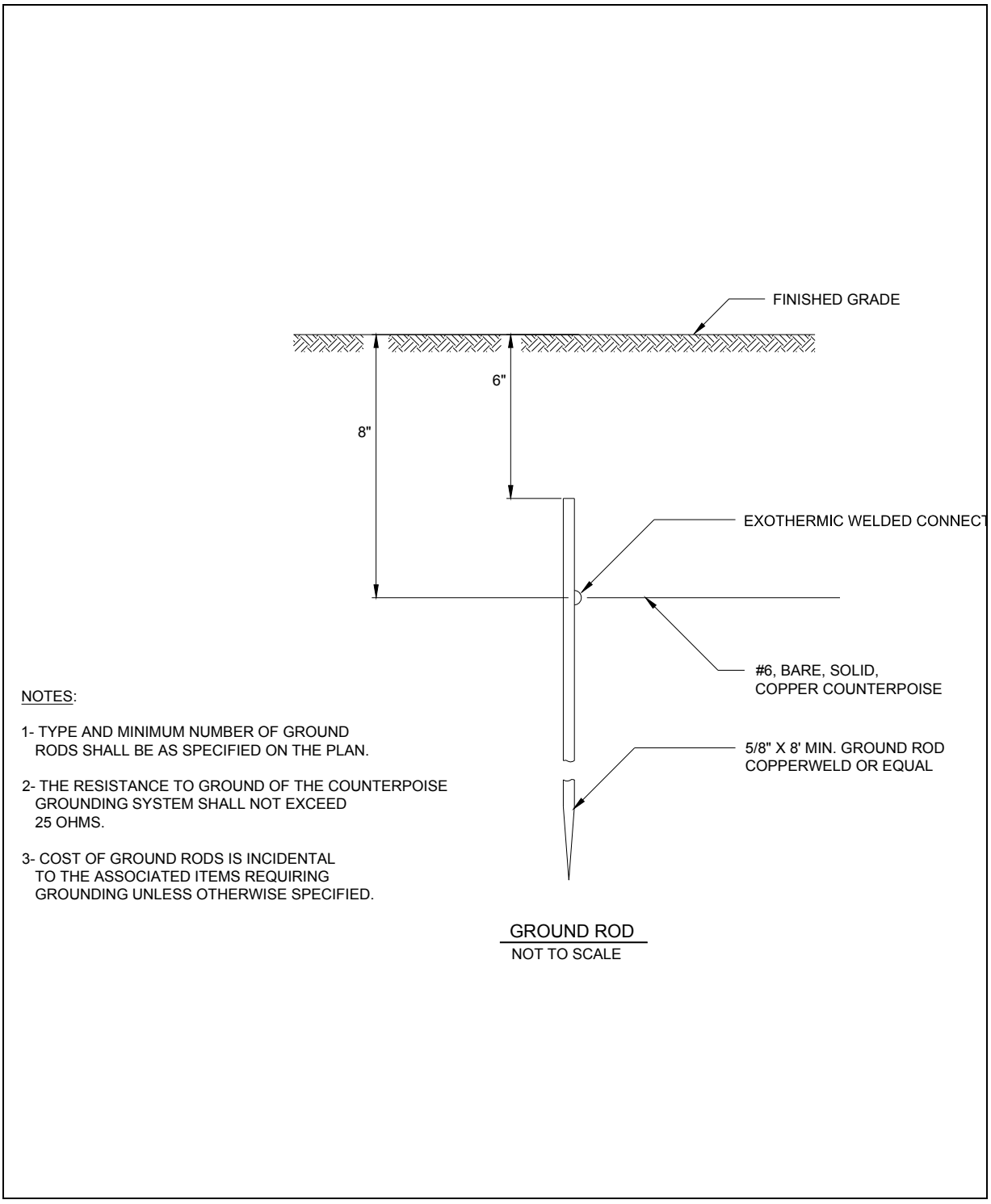


Figure 117 Typical Standard Details for Runway and Taxiway Edge Lights – GL-600 Sheet 1D – Ground Rod

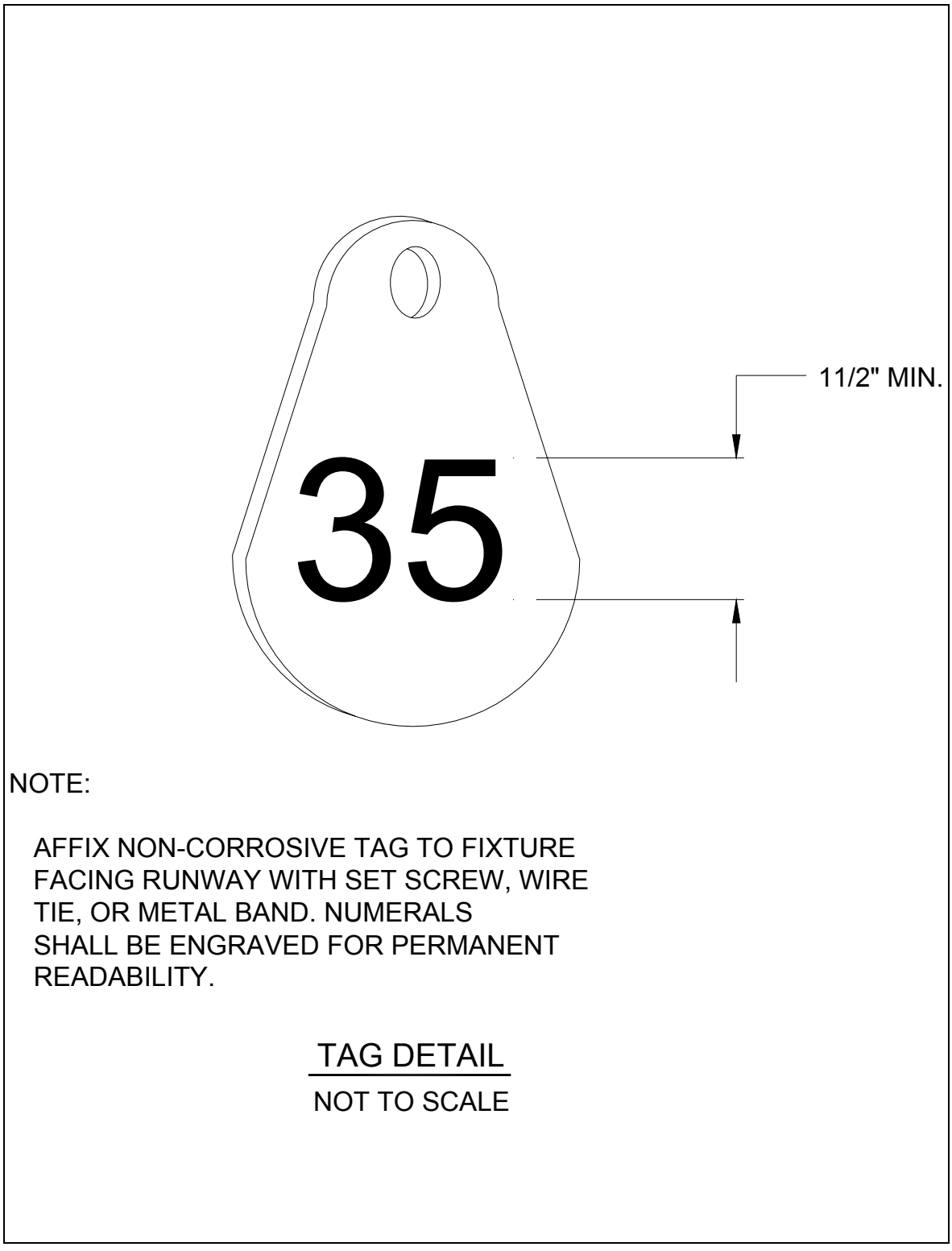


Figure 118 Typical Standard Details for Runway and Taxiway Edge Lights – GL-600 Sheet 1E – Tag Detail

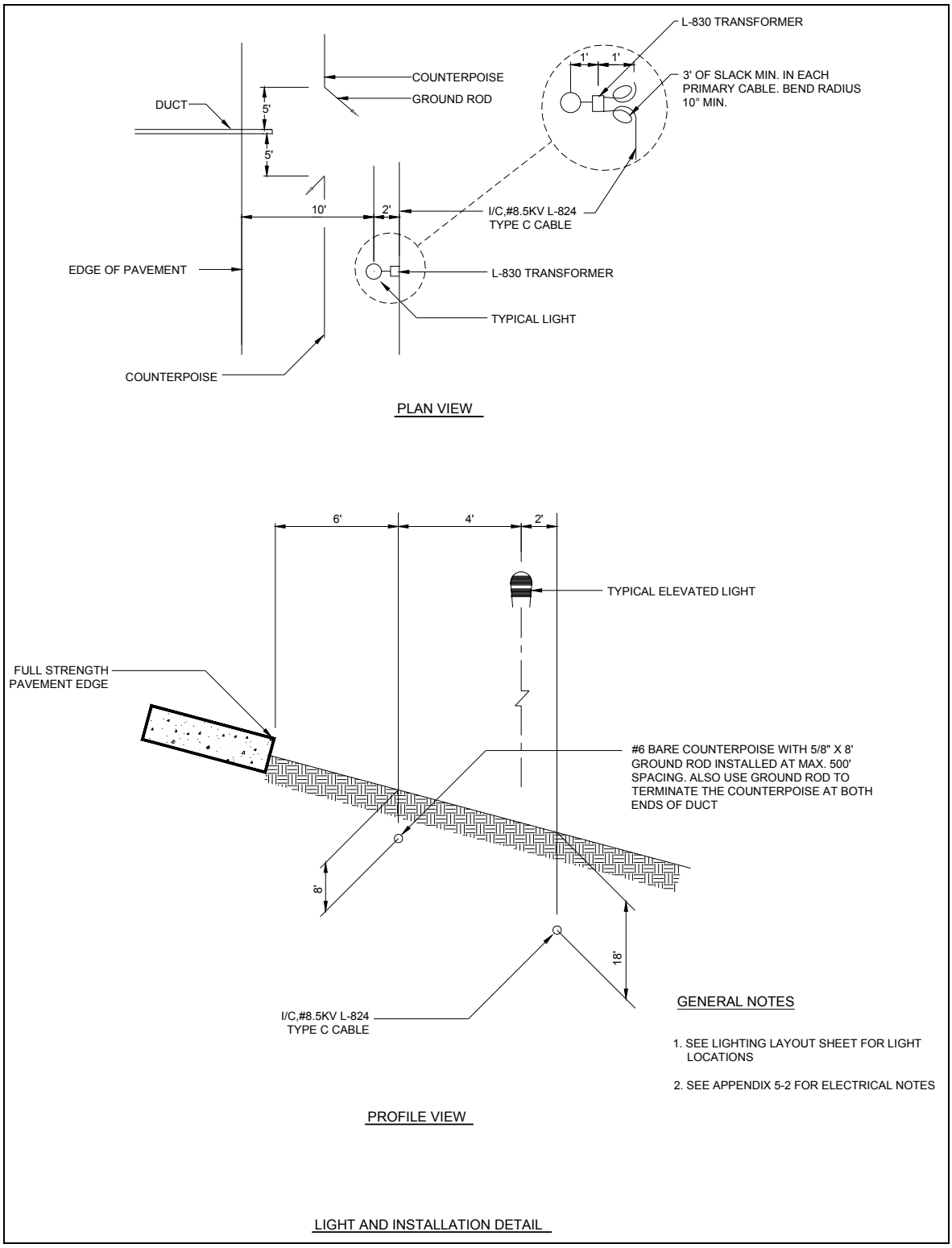


Figure 119 Typical Standard Details for Runway and Taxiway Edge Lights – GL-600 Sheet 1F – Light & Installation Detail

A5-1.2 Sheet 2

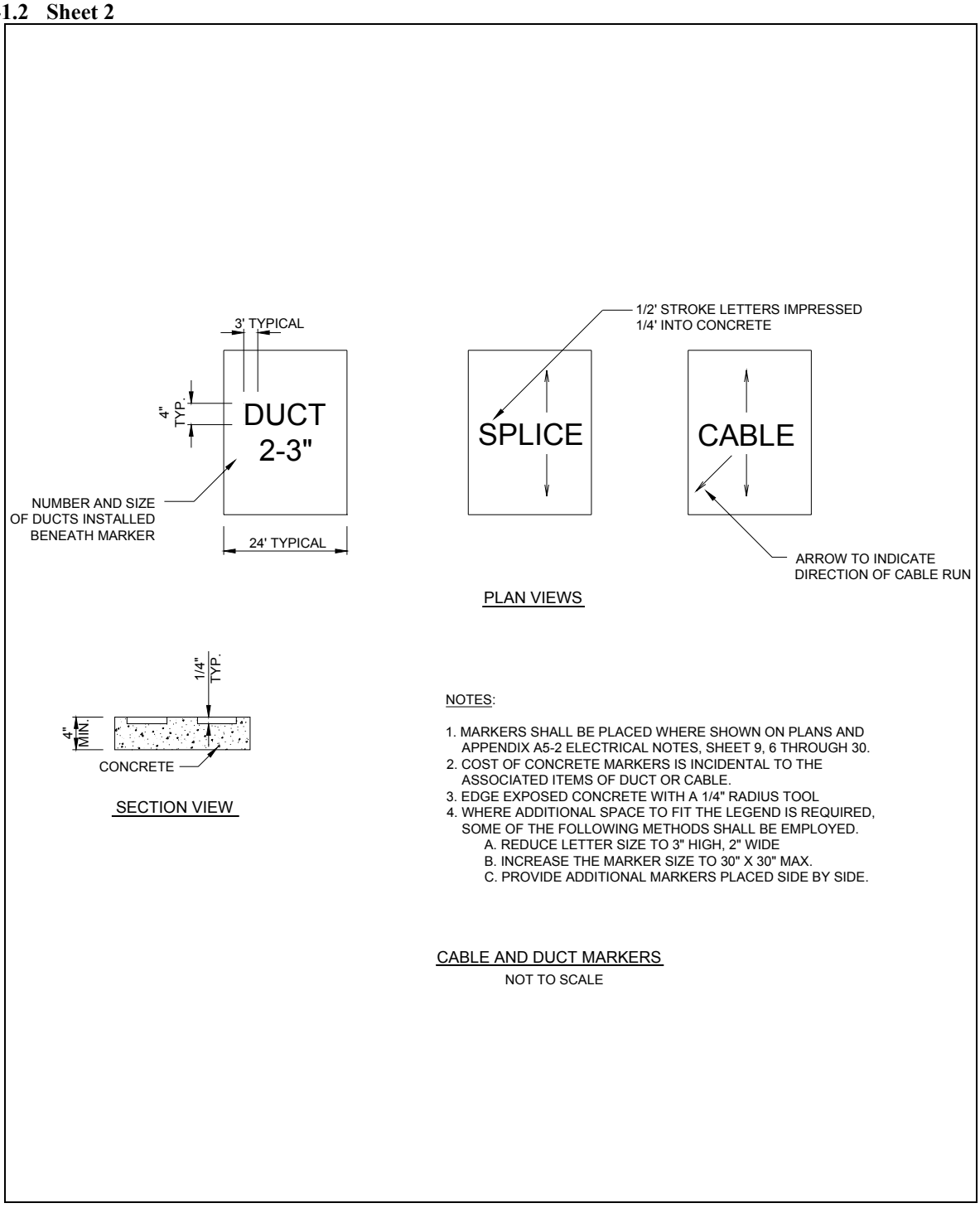


Figure 120 Standard Details for Underground Cable Installation – GL-600 Sheet 2A – Cable and Duct Markers

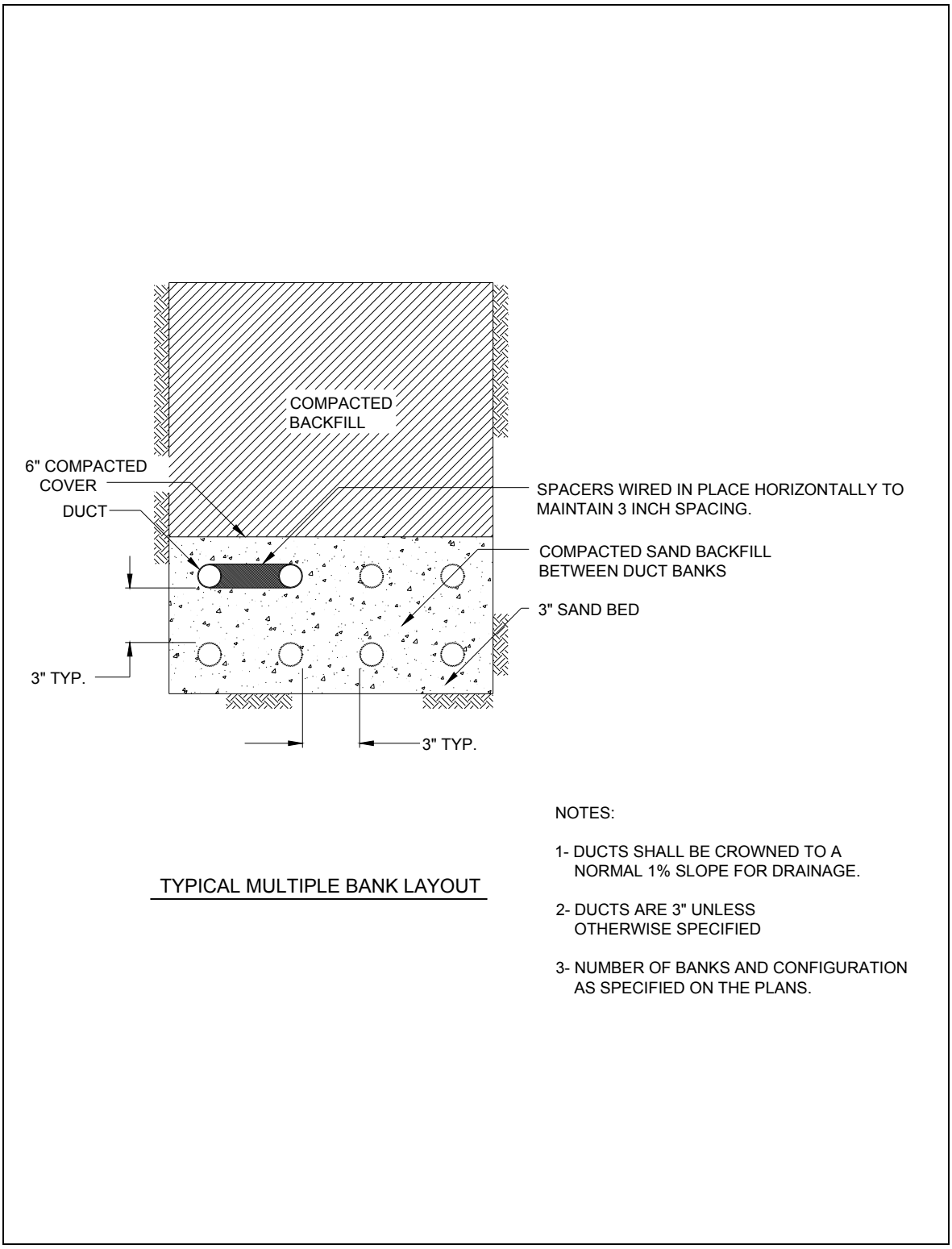


Figure 121 Standard Details for Underground Cable Installation – GL-600 Sheet 2B – Typical Multiple Bank Layout

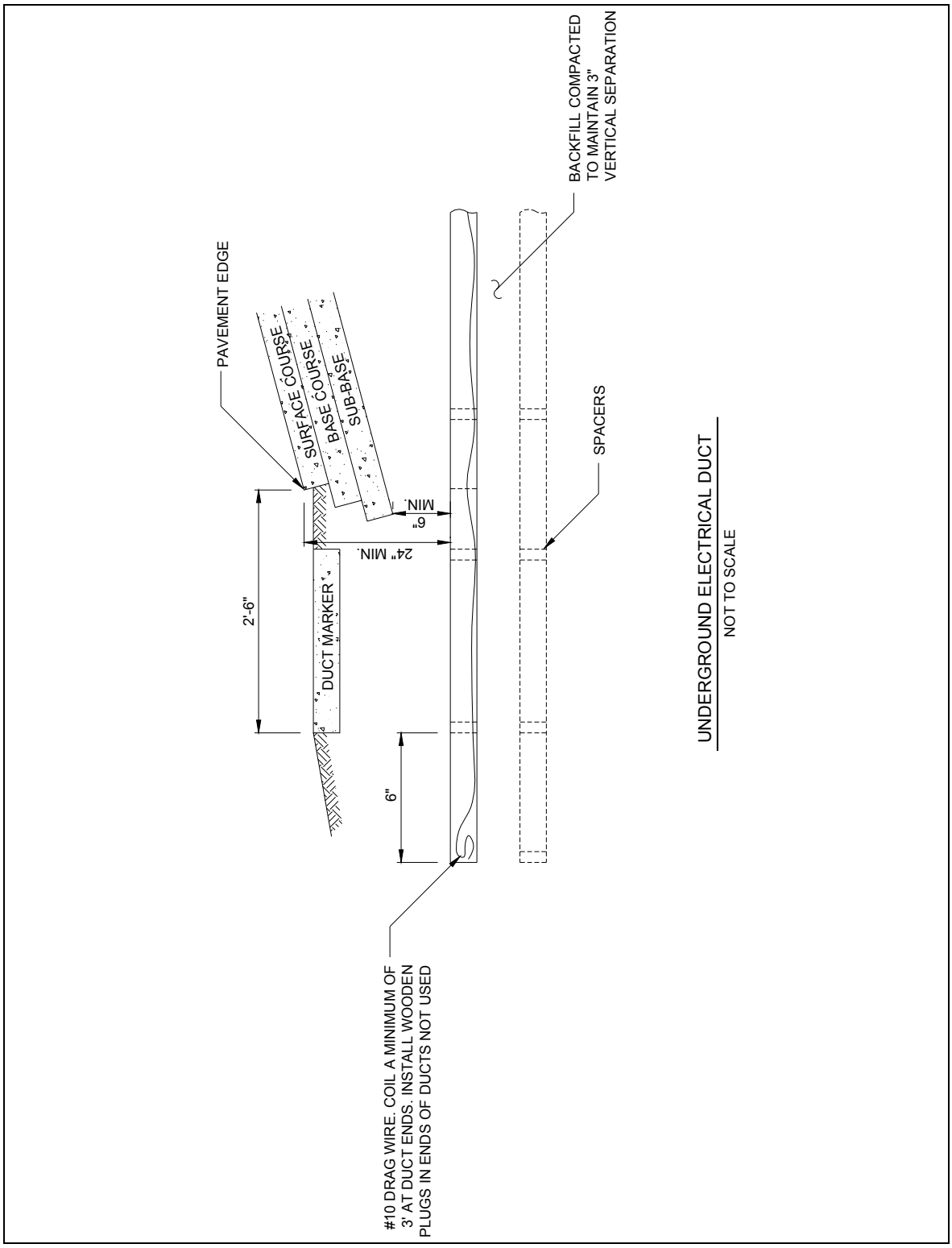


Figure 122 Standard Details for Underground Cable Installation – GL-600 Sheet 2C – Underground Electrical Duct

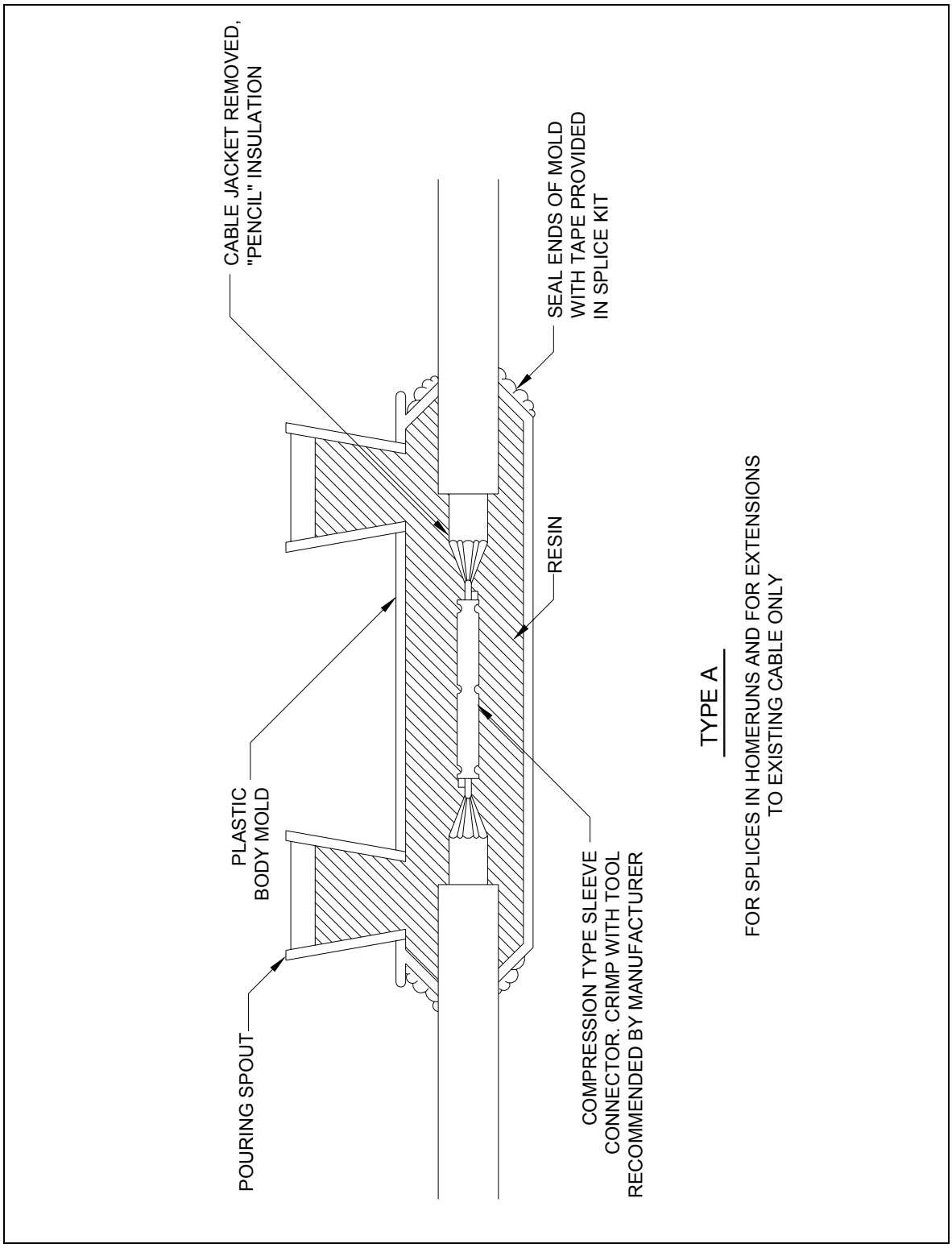


Figure 123 Standard Details for Underground Cable Installation – GL-600 Sheet 2D – Type A

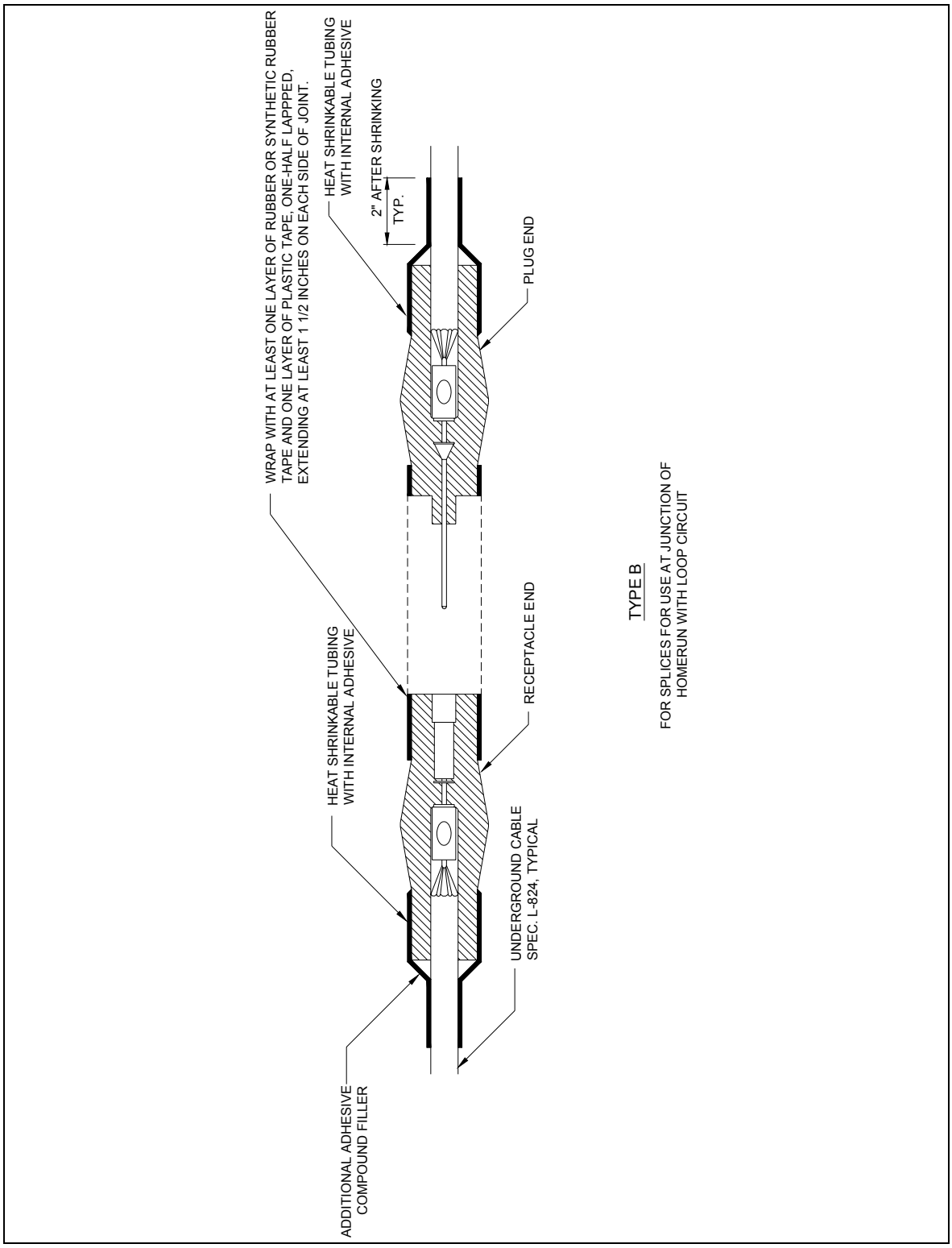


Figure 124 Standard Details for Underground Cable Installation – GL-600 Sheet 2E – Type B

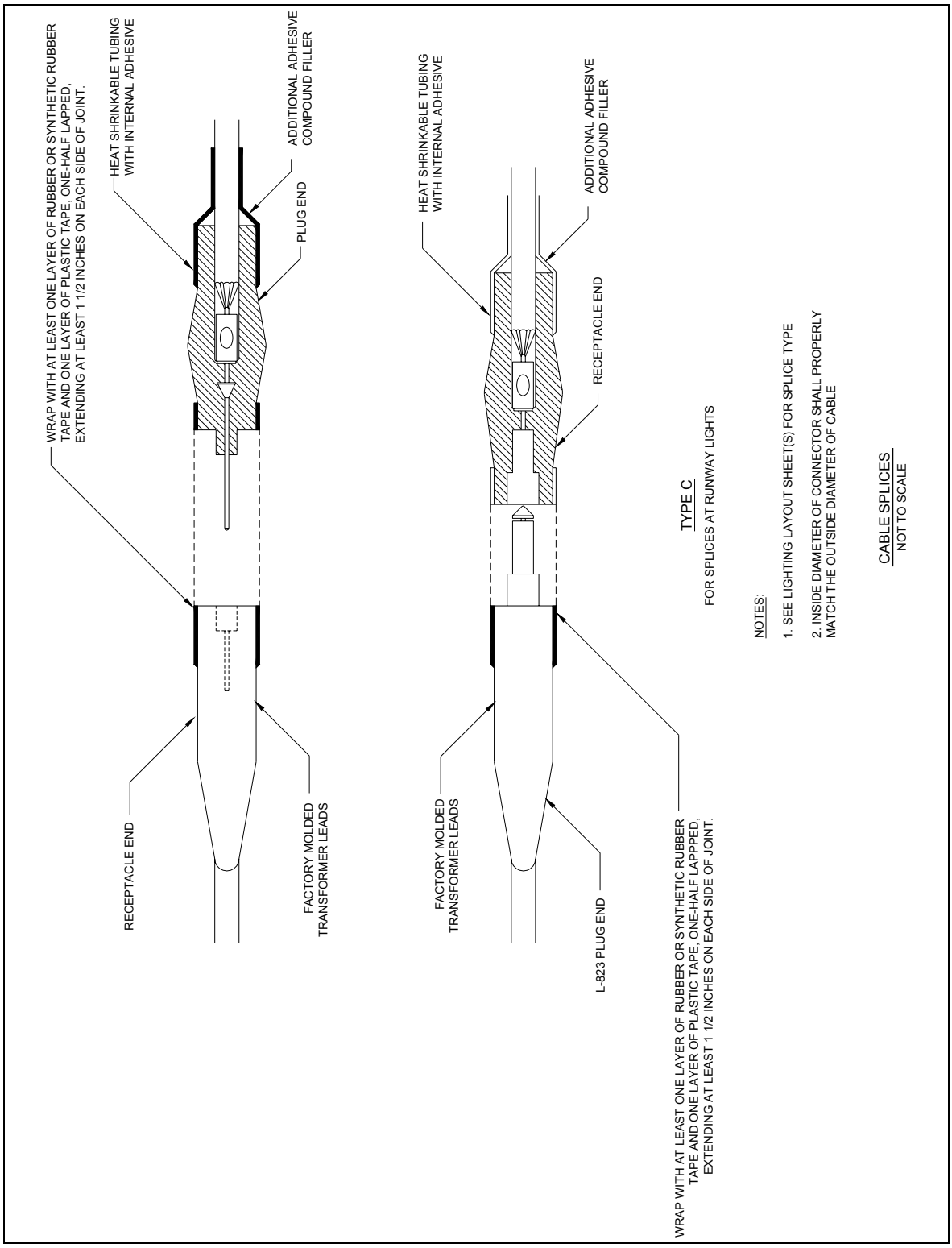


Figure 125 Standard Details for Underground Cable Installation – GL-600 Sheet 2F – Type C

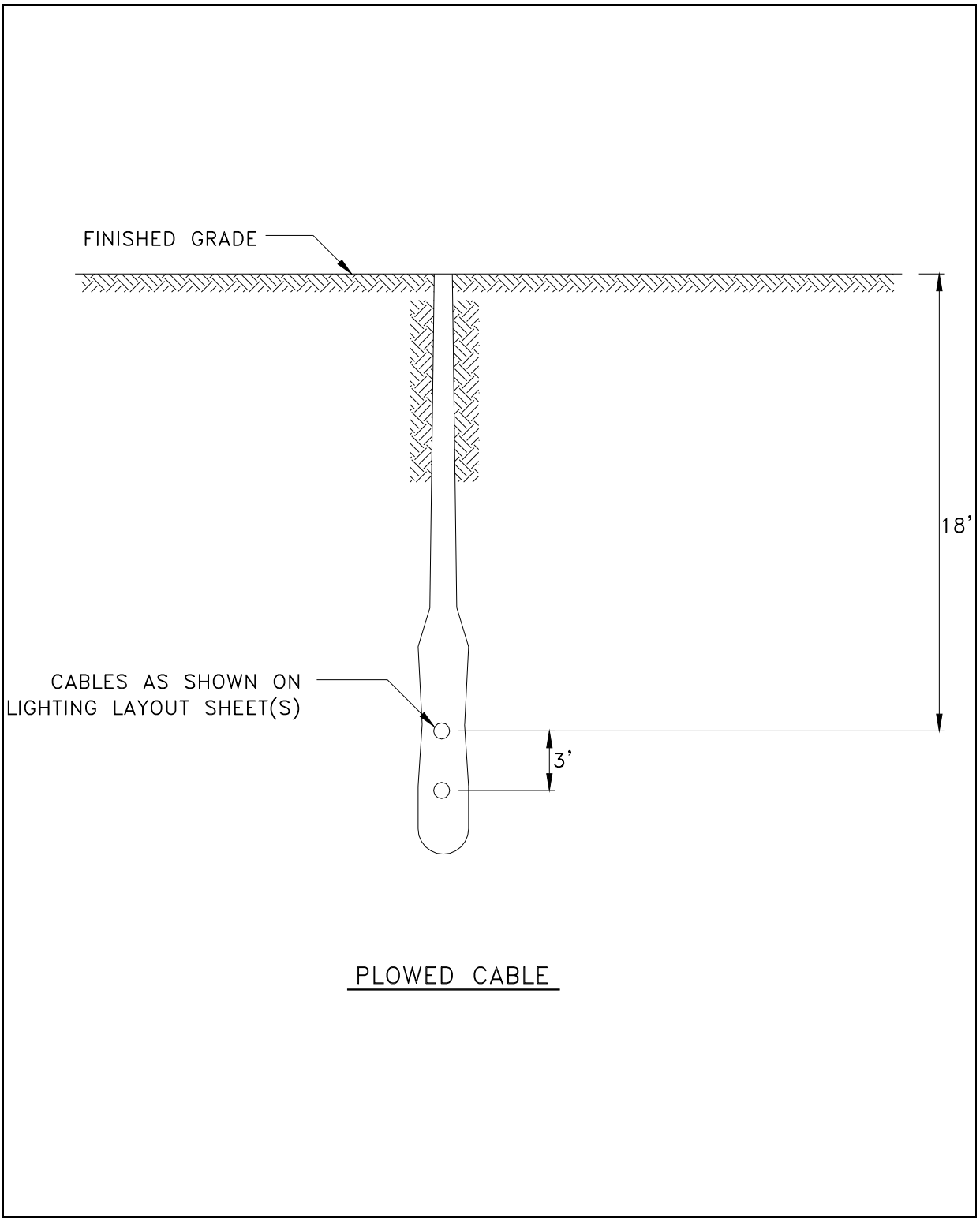
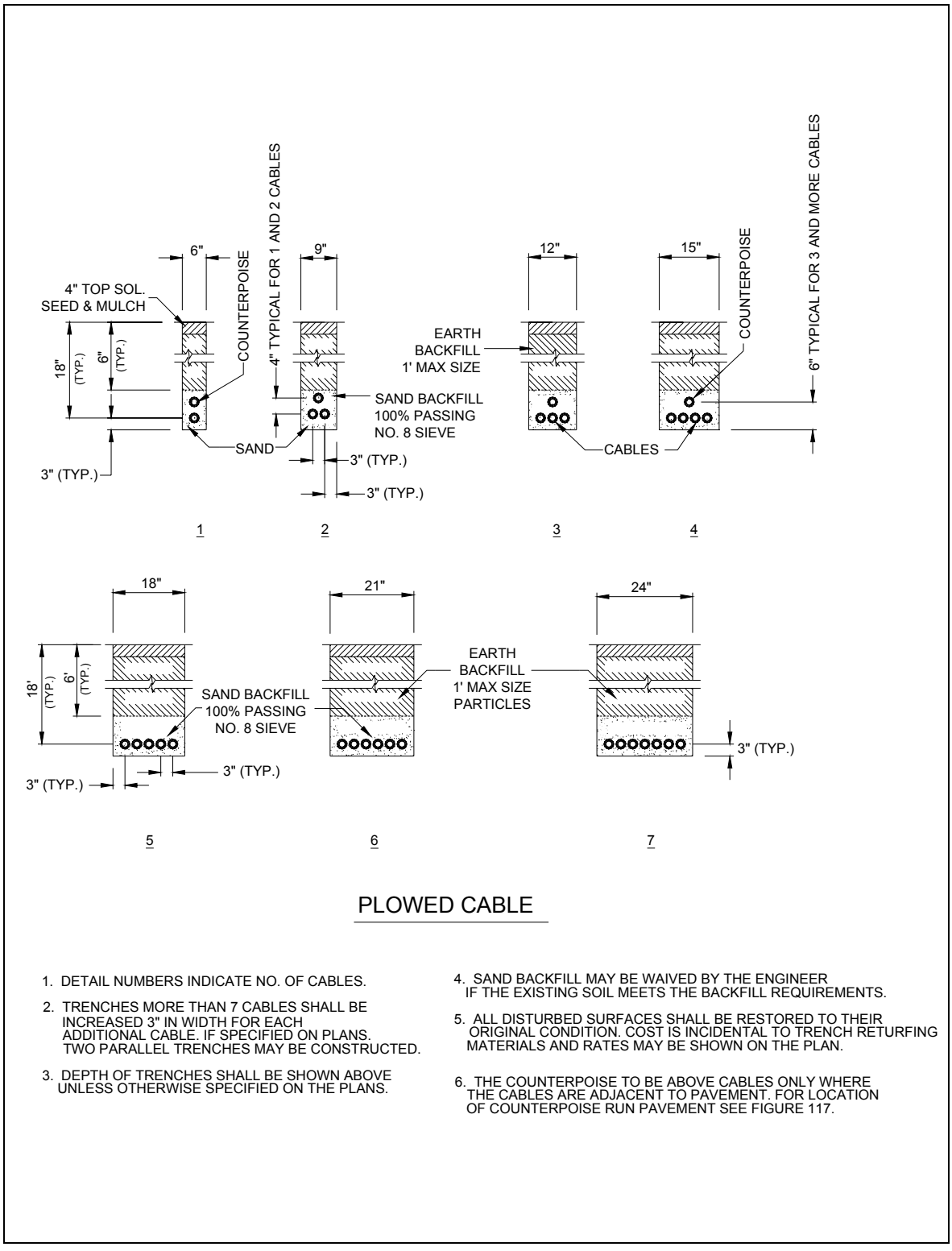


Figure 126 Standard Details for Underground Cable Installation – GL-600 Sheet 2G – Plowed Cable



PLOWED CABLE

1. DETAIL NUMBERS INDICATE NO. OF CABLES.
2. TRENCHES MORE THAN 7 CABLES SHALL BE INCREASED 3" IN WIDTH FOR EACH ADDITIONAL CABLE. IF SPECIFIED ON PLANS. TWO PARALLEL TRENCHES MAY BE CONSTRUCTED.
3. DEPTH OF TRENCHES SHALL BE SHOWN ABOVE UNLESS OTHERWISE SPECIFIED ON THE PLANS.
4. SAND BACKFILL MAY BE WAIVED BY THE ENGINEER IF THE EXISTING SOIL MEETS THE BACKFILL REQUIREMENTS.
5. ALL DISTURBED SURFACES SHALL BE RESTORED TO THEIR ORIGINAL CONDITION. COST IS INCIDENTAL TO TRENCH RETURFING MATERIALS AND RATES MAY BE SHOWN ON THE PLAN.
6. THE COUNTERPOISE TO BE ABOVE CABLES ONLY WHERE THE CABLES ARE ADJACENT TO PAVEMENT. FOR LOCATION OF COUNTERPOISE RUN PAVEMENT SEE FIGURE 117.

Figure 127 Standard Details for Underground Cable Installation – GL-600 Sheet 2H – Plowed Cable

A5-1.3 Sheet 3

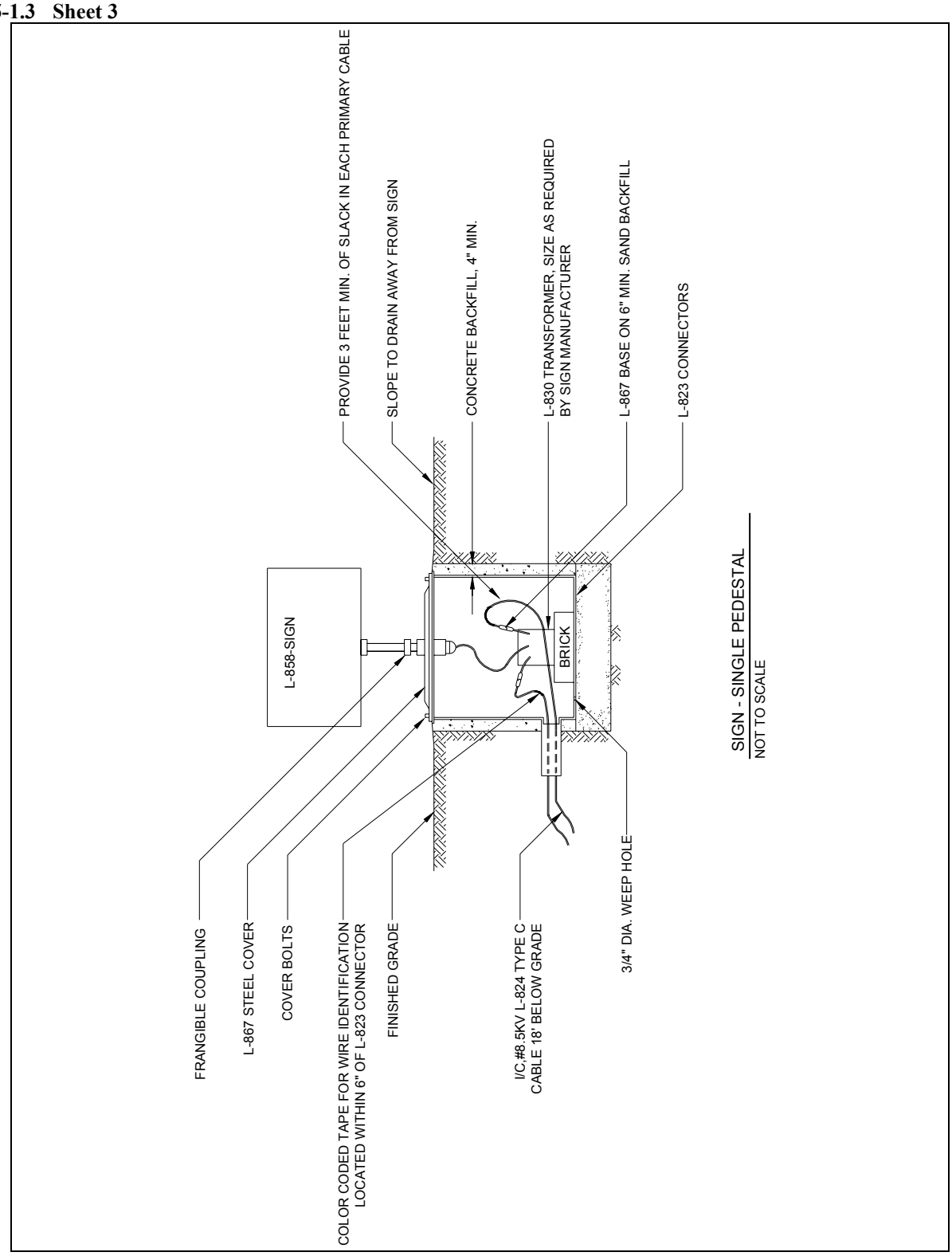


Figure 128 Standard Details for Taxiway Hold and Guidance Sign – GL-600 Sheet 3A – Sign – Single Pedestal

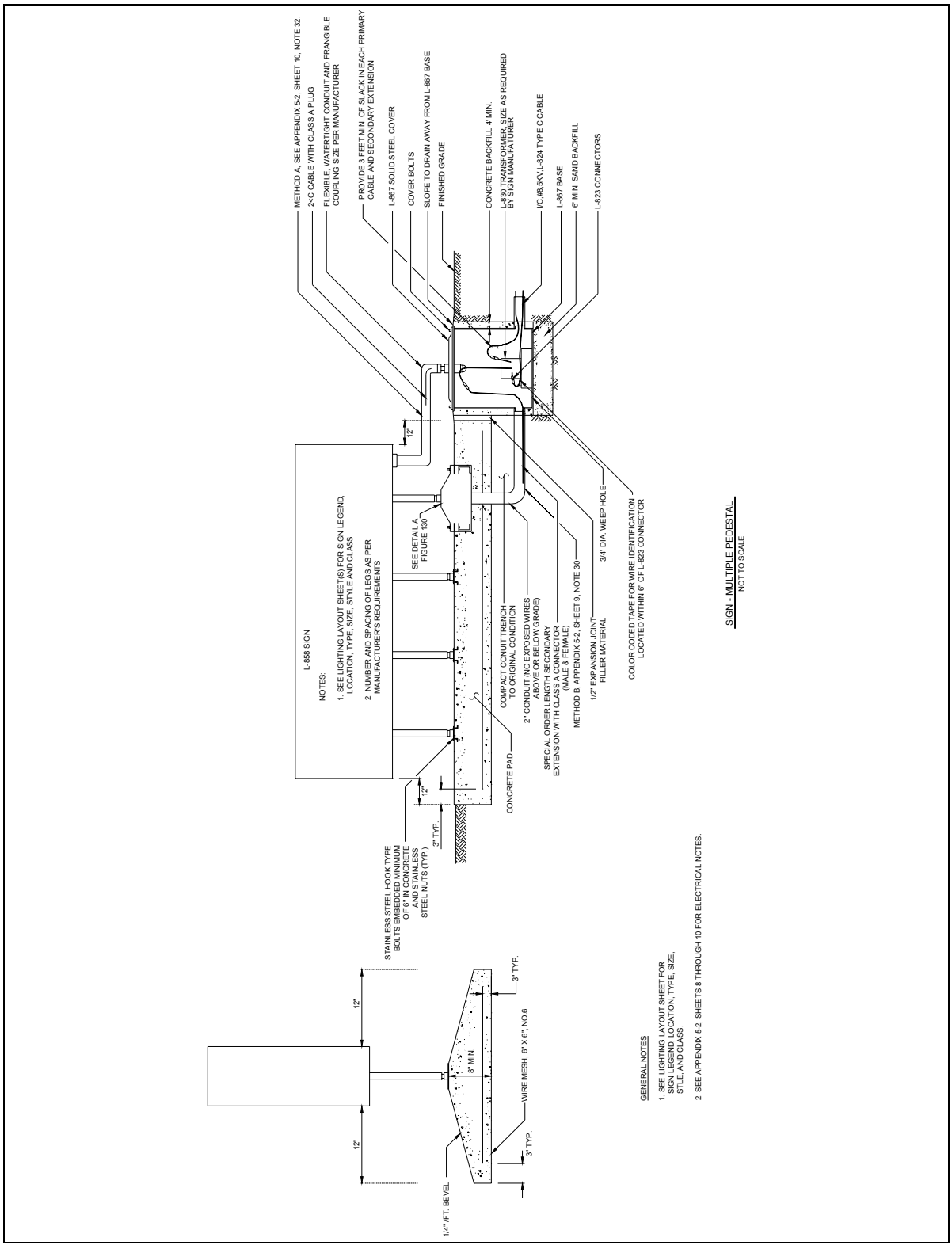


Figure 129 Standard Details for Taxiway Hold & Guidance Sign – GL-600 Sheet 3B– Sign – Multiple Pedestal

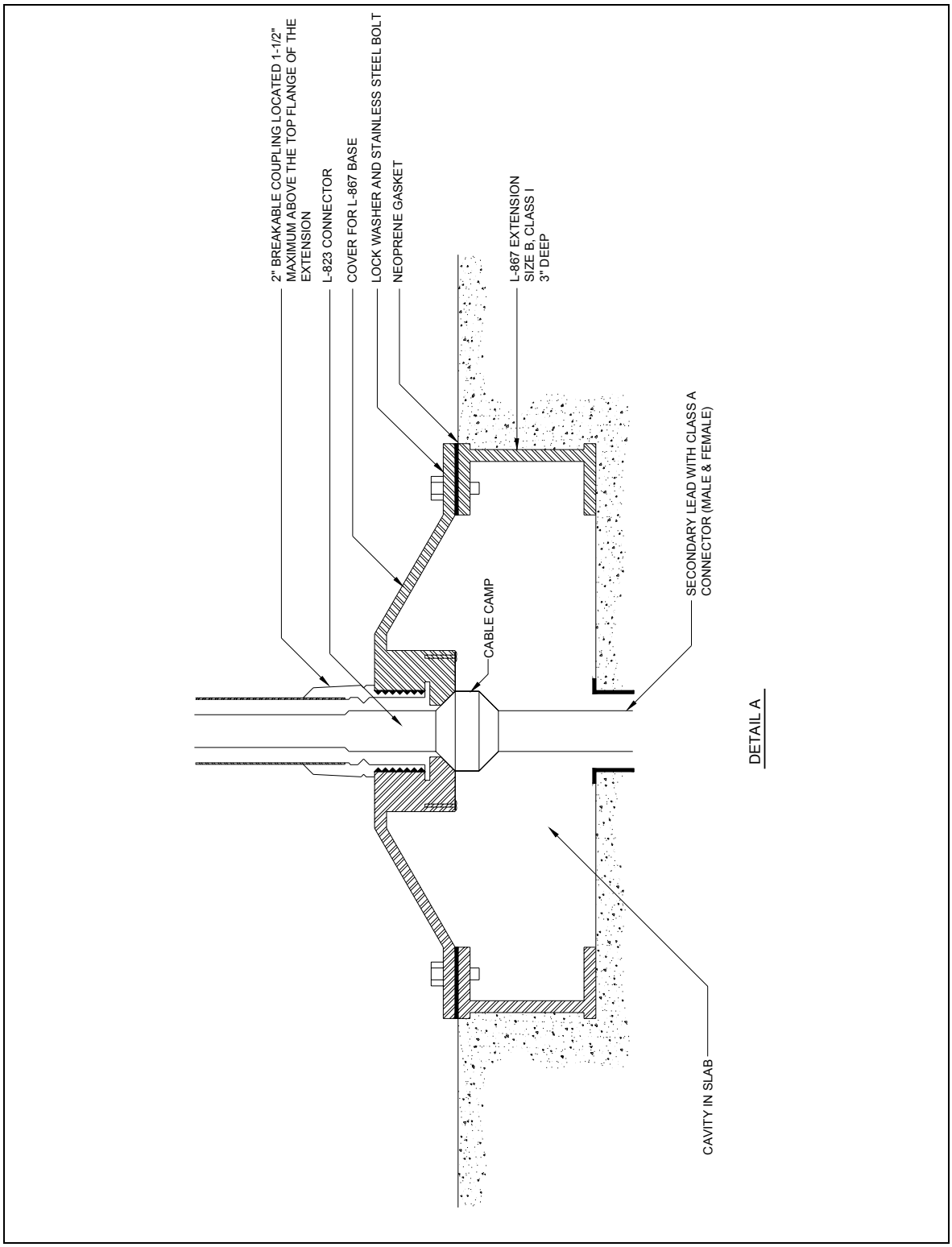


Figure 130 Standard Details for Taxiway Hold & Guidance Sign – GL-600 Sheet 3C – Detail A

A5-1.4 Sheet 4

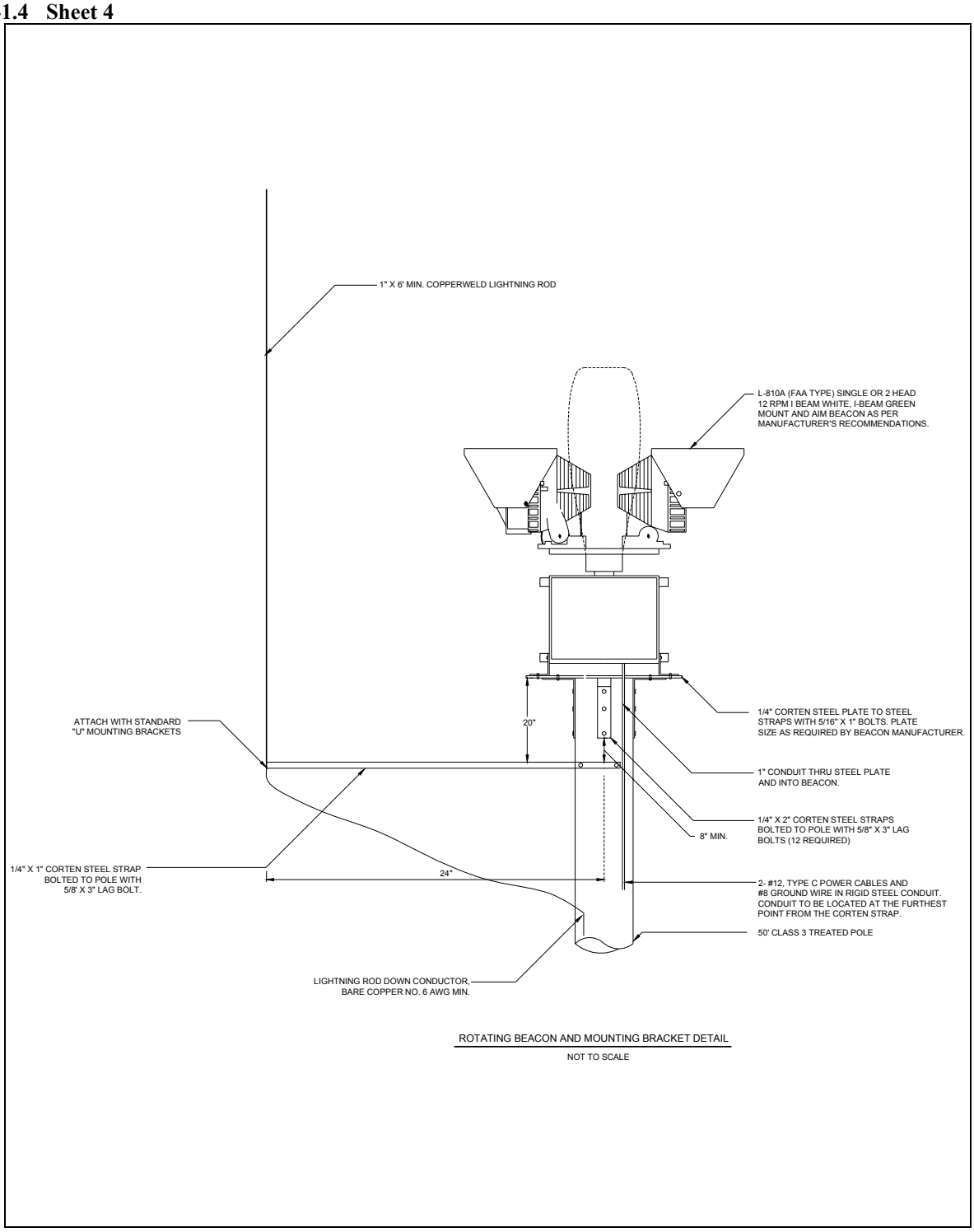


Figure 131 Standard Details for Pivoting Rotating Beacon Pole – GL-600 Sheet 4A – Rotating Beacon & Mounting Bracket Detail

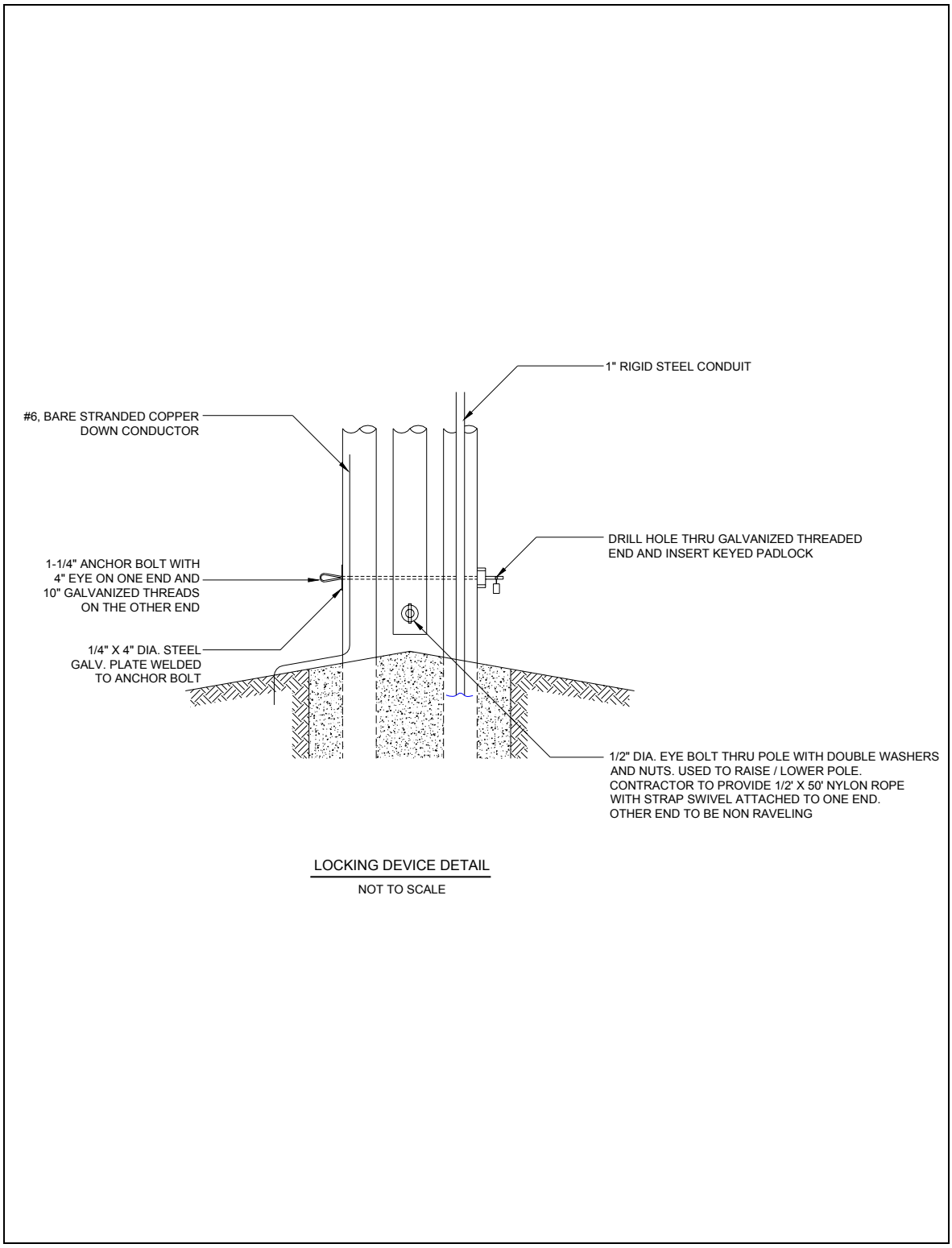


Figure 132 Standard Details for Pivoting Rotating Beacon Pole – GL-600 Sheet 4B – Locking Device Detail

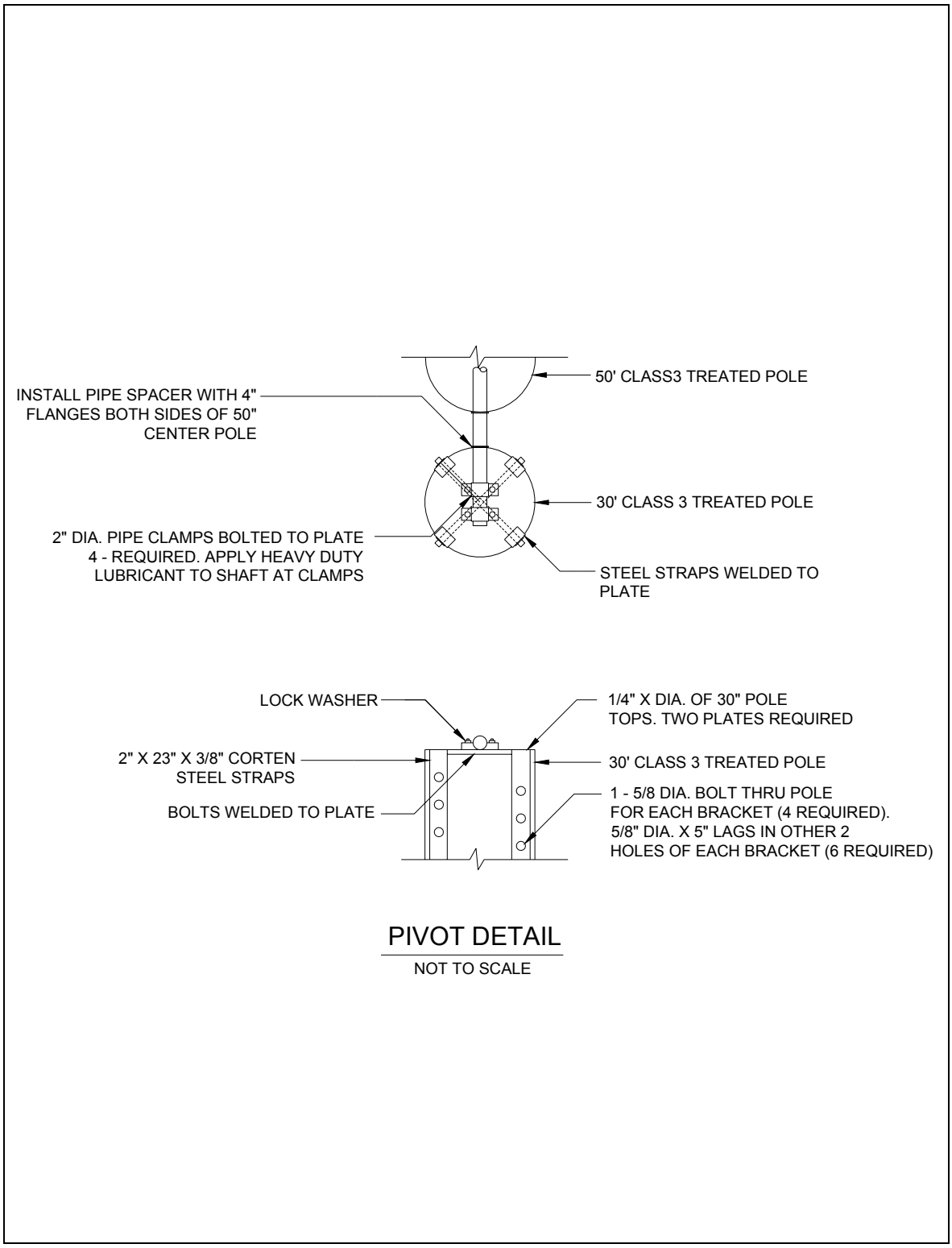


Figure 133 Standard Details for Pivoting Rotating Beacon Pole – GL-600 Sheet 4C – Pivot Detail

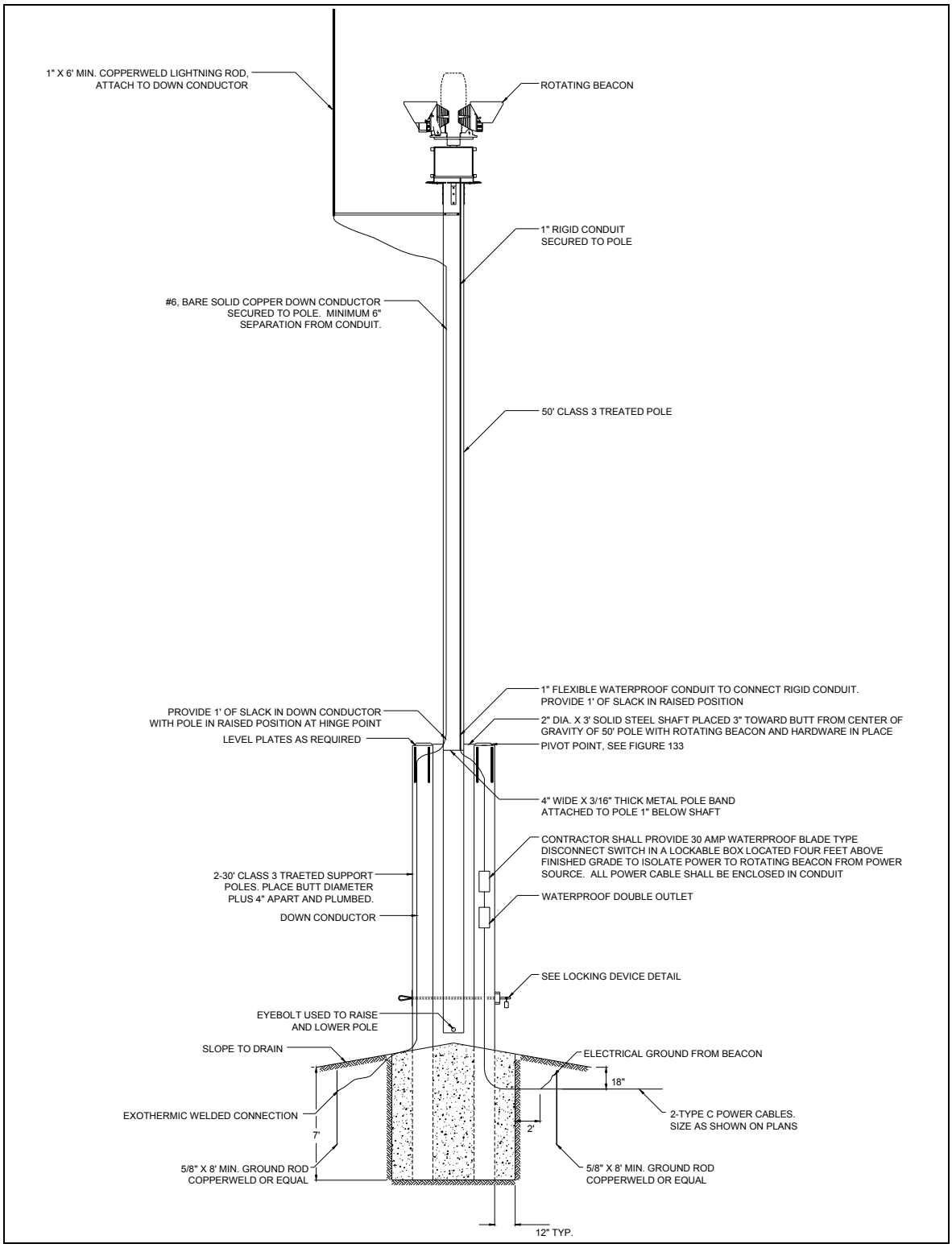


Figure 134 Standard Details for Pivoting Rotating Beacon Pole – GL-600 Sheet 4D

A5-1.5 Sheet 5

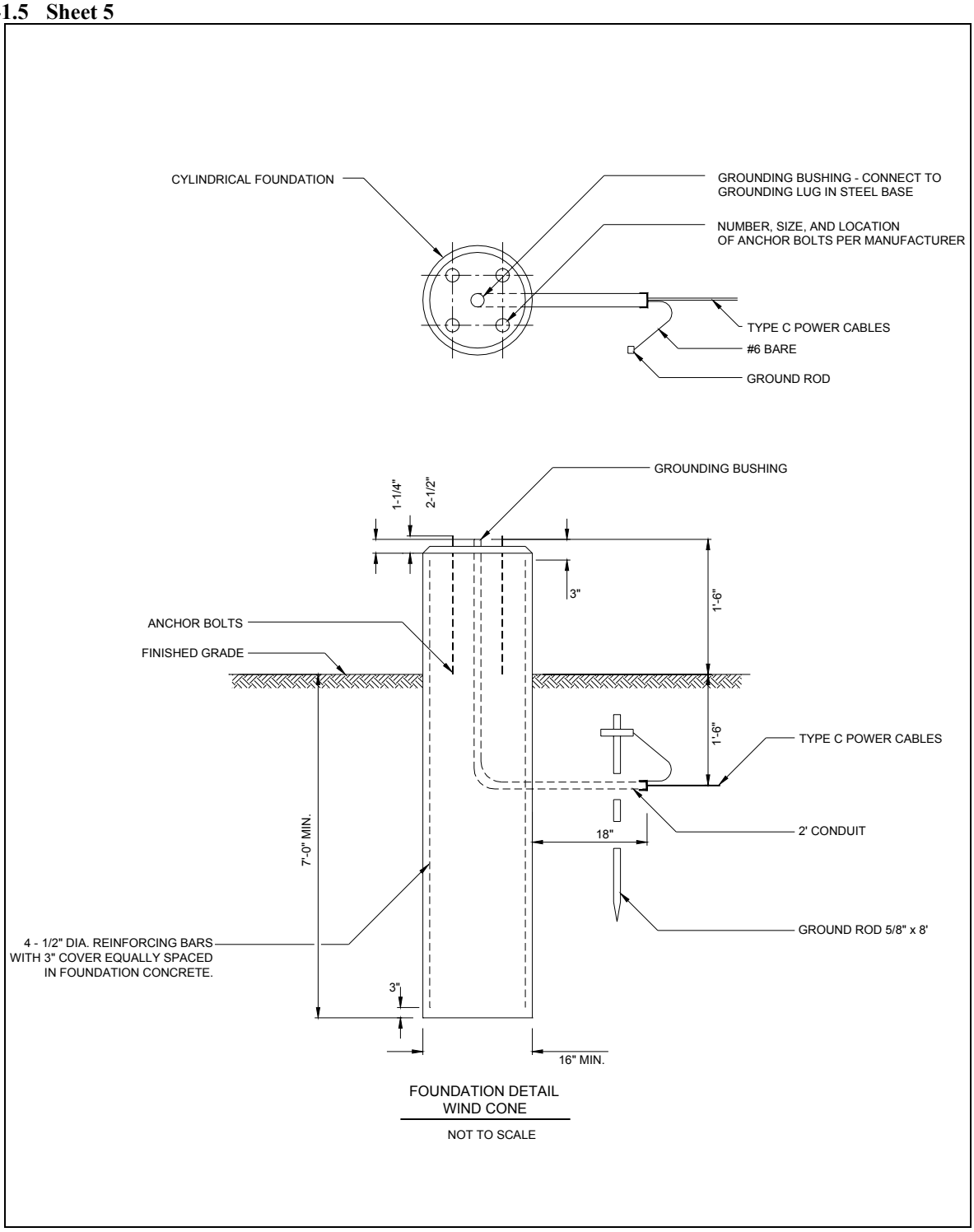


Figure 135 Standard Details for Wind Cone – GL-600 Sheet 5A – Foundation Detail Wind Cone

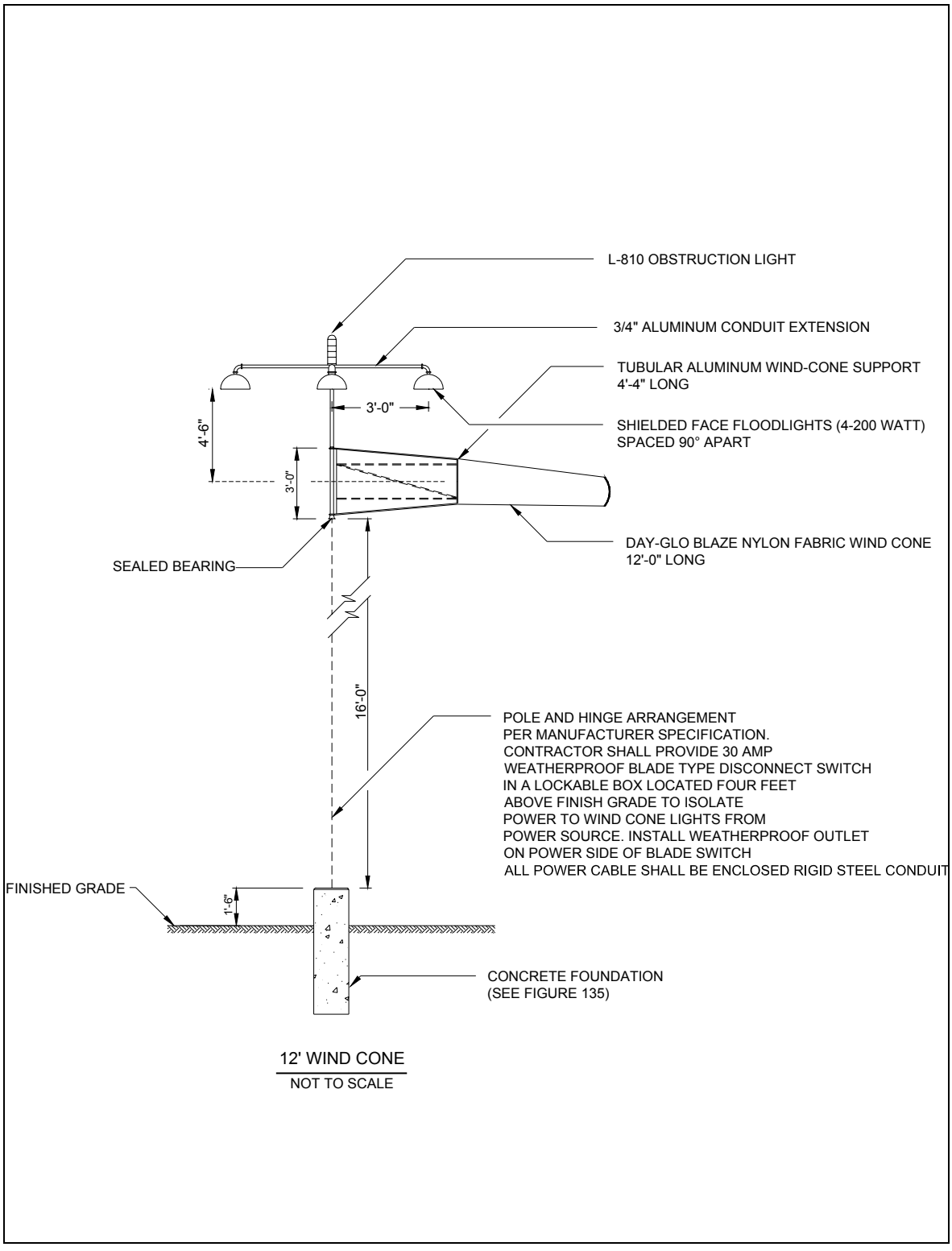


Figure 136 Standard Details for Wind Cone – GL-600 Sheet 5B – 12’ Wind Cone

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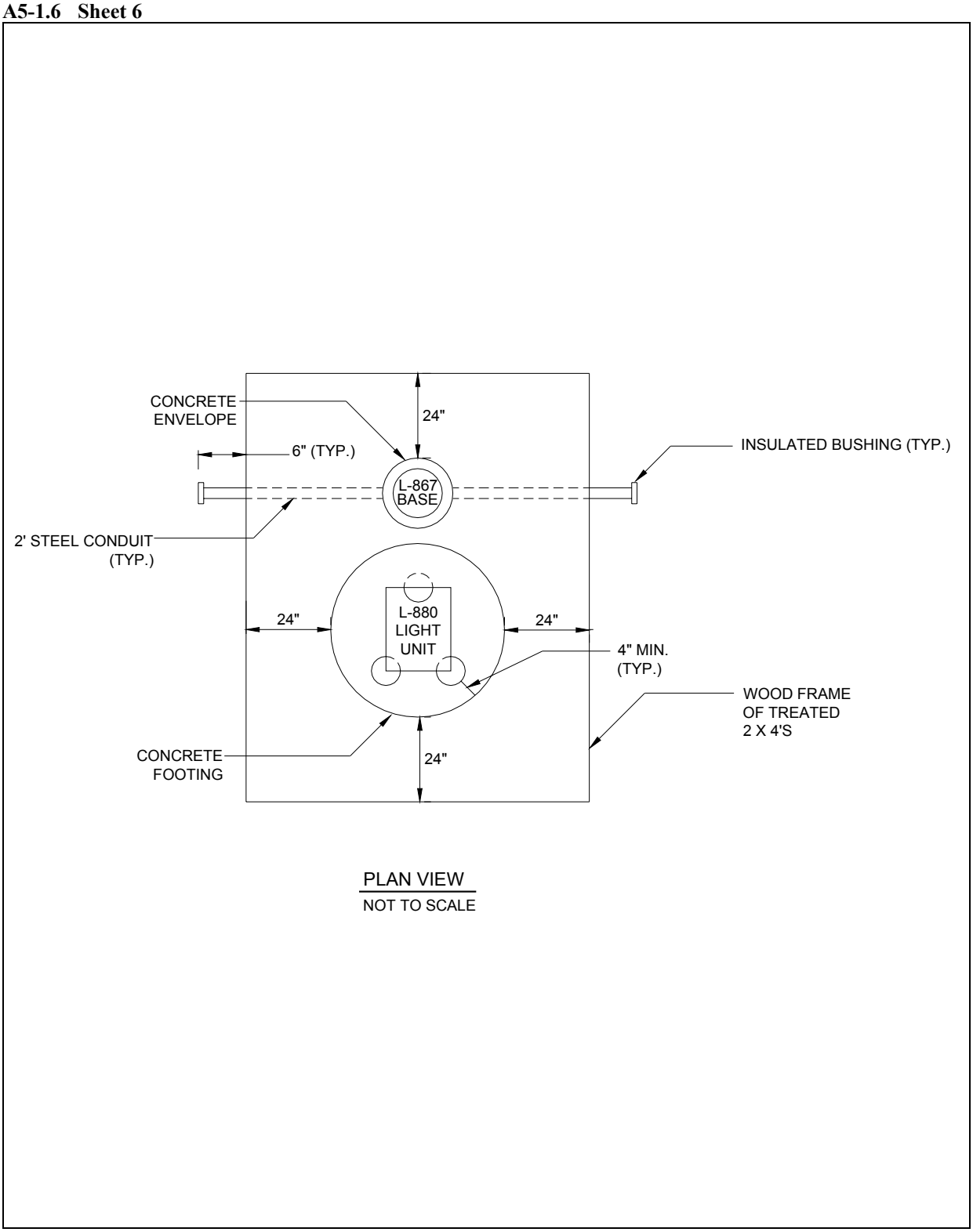

Figure 137 Standard Details for Precision Approach Path Indicators (PAPIs) – GL-600 Sheet 6A – Plan View

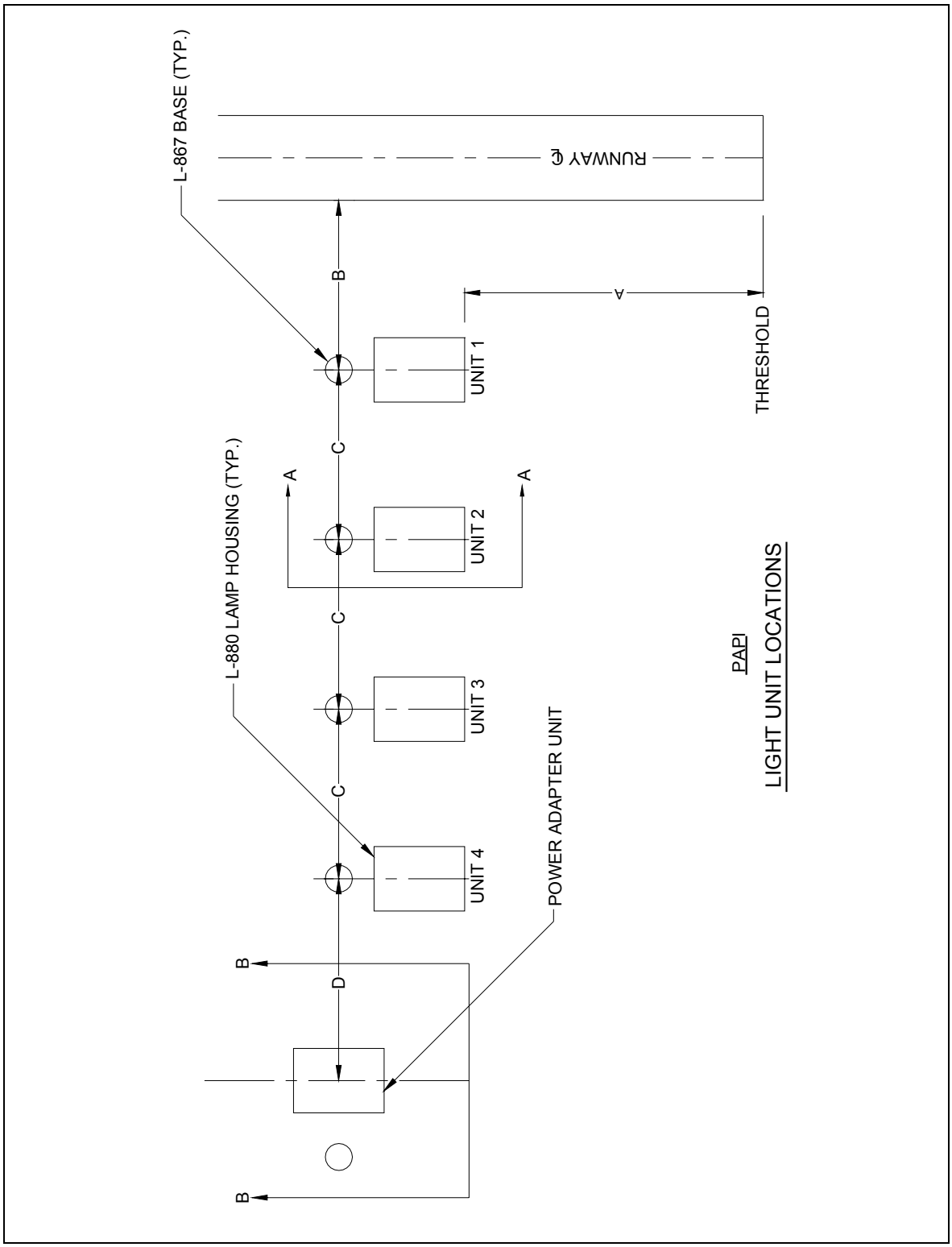

Figure 138 Standard Details for Precision Approach Path Indicators (PAPIs) – GL-600 Sheet 6B – PAPI Light Unit Locations

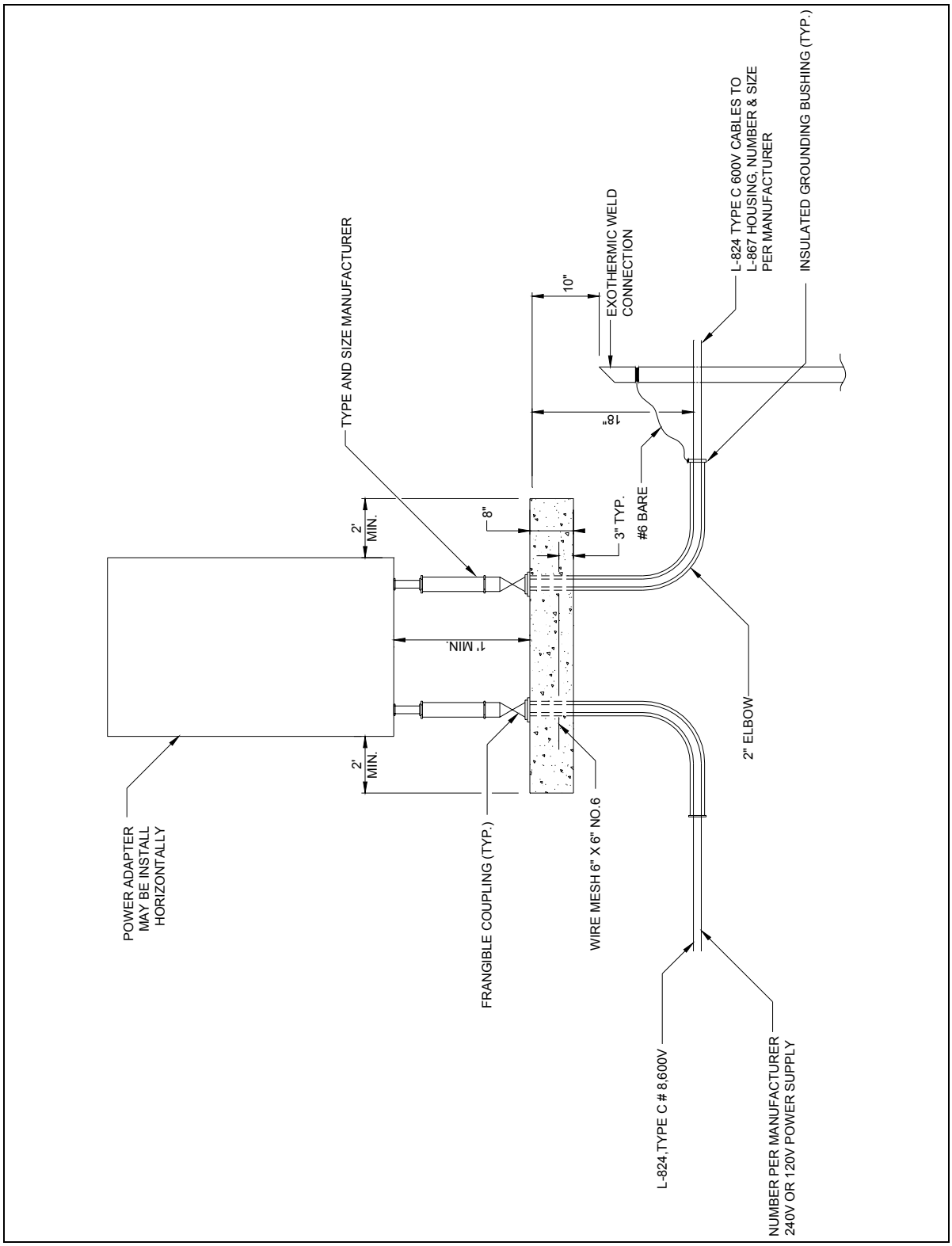

Figure 139 Standard Details for Precision Approach Path Indicators (PAPIs) – GL-600 Sheet 6C

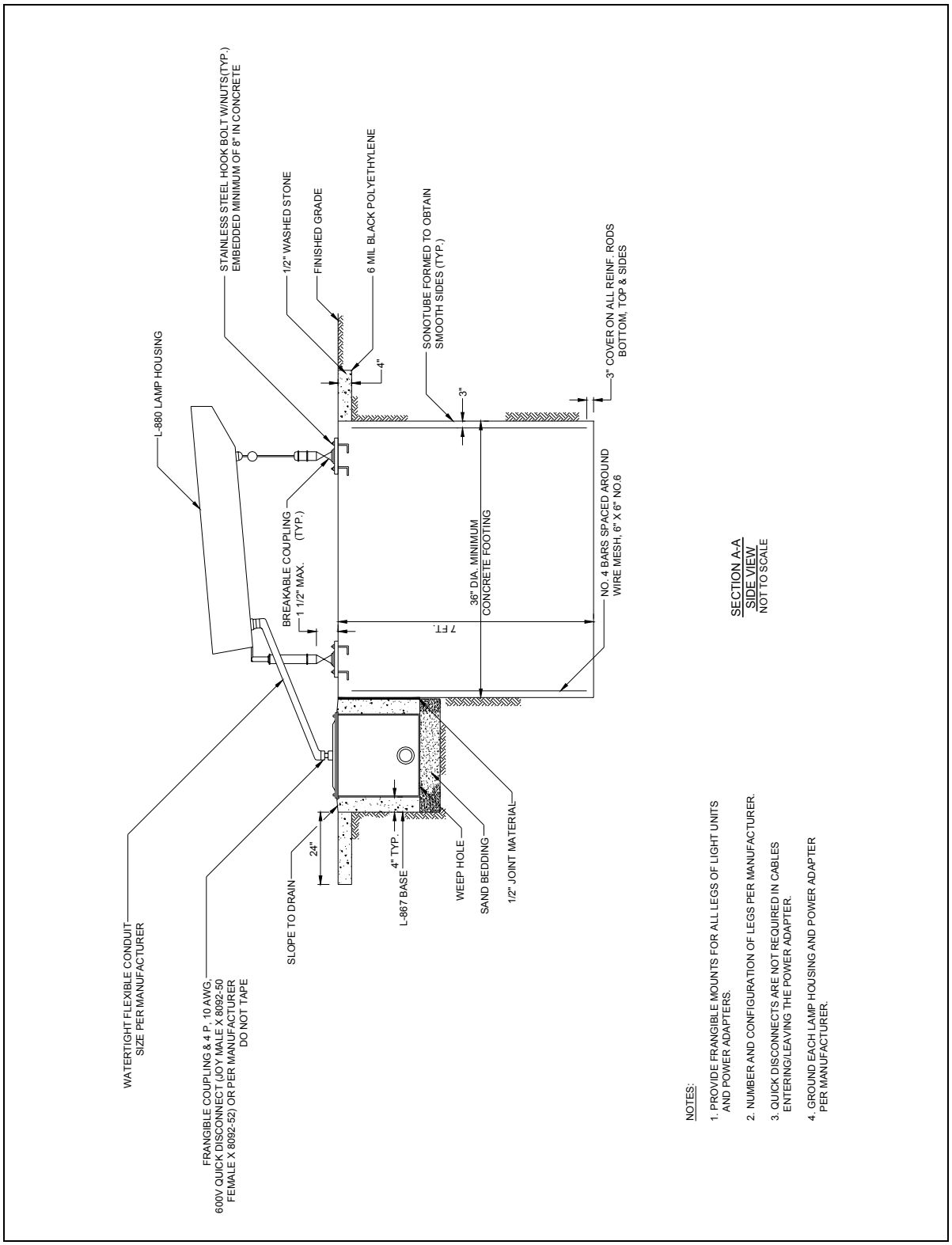

Figure 140 Standard Details for Precision Approach Path Indicators (PAPIs) – GL-600 Sheet 6D – Section A-A

DESCRIPTION	RUNWAY END	RUNWAY END	RUNWAY END	RUNWAY END
DIMENSION A				
DIMENSION B				
DIMENSION B				
DIMENSION C				
DIMENSION D				
THRESHOLD ELEVATION				
APERTURE ELEVATION UNIT 1				
APERTURE ELEVATION UNIT 2				
APERTURE ELEVATION UNIT 3				
APERTURE ELEVATION UNIT 4				
AIMING ANGLE UNIT 1				
AIMING ANGLE UNIT 2				
AIMING ANGLE UNIT 3				
AIMING ANGLE UNIT 4				

BASE DESIGN & LAYOUT IN CHAPTER 4

GENERAL NOTES:

1. APPLY "NEVER SEEZ" OR APPROVED EQUAL TO ALL THREADED BOLTS AND CONNECTIONS.

2. AZIMUTHAL AIMING. EACH LIGHT UNIT SHALL BE AIMED OUTWARD INTO APPROACH ZONE ON A LINE PARALLEL TO THE RUNWAY CENTERLINE WITHIN A TOLERANCE OF ± 1/2 DEGREE.

3. MOUNTING HEIGHT TOLERANCES. THE BEAM CENTERS OF ALL LIGHT UNITS SHALL BE WITHIN 1 INCH OF A HORIZONTAL PLANE, THIS HORIZONTAL PLANE SHALL BE WITHIN ± 1 FOOT (0.3M) OF THE ELEVATION OF THE RUNWAY CENTERLINE AT THE INTERCEPT POINT OF THE VISUAL GLIDEPATH WITH THE RUNWAY EXCEPT AT LOCATIONS WHERE THE LIGHT UNITS ARE RAISED TO CLEAR SNOW.

4. TOLERANCE ALONG LINE PERPENDICULAR TO RUNWAY. THE FRONT FACE OF EACH LIGHT UNIT IN A BAR SHALL BE LOCATED ON A LINE PERPENDICULAR TO THE RUNWAY CENTERLINE WITHIN ± 6 INCHES.

5. THE POWER & CONTROL UNIT SHALL BE STYLE A, CLASS II.

6. SEE APPENDIX 5-2, SHEETS 8 THROUGH 10, FOR ELECTRICAL NOTES.

7. THE DIFFERENCE IN LATERAL SPACING BETWEEN THE LIGHT UNITS SHALL NOT EXCEED ONE FOOT.

Figure 141 Standard Details for Precision Approach Path Indicators (PAPIs) – GL-600 Sheet 6E Chart

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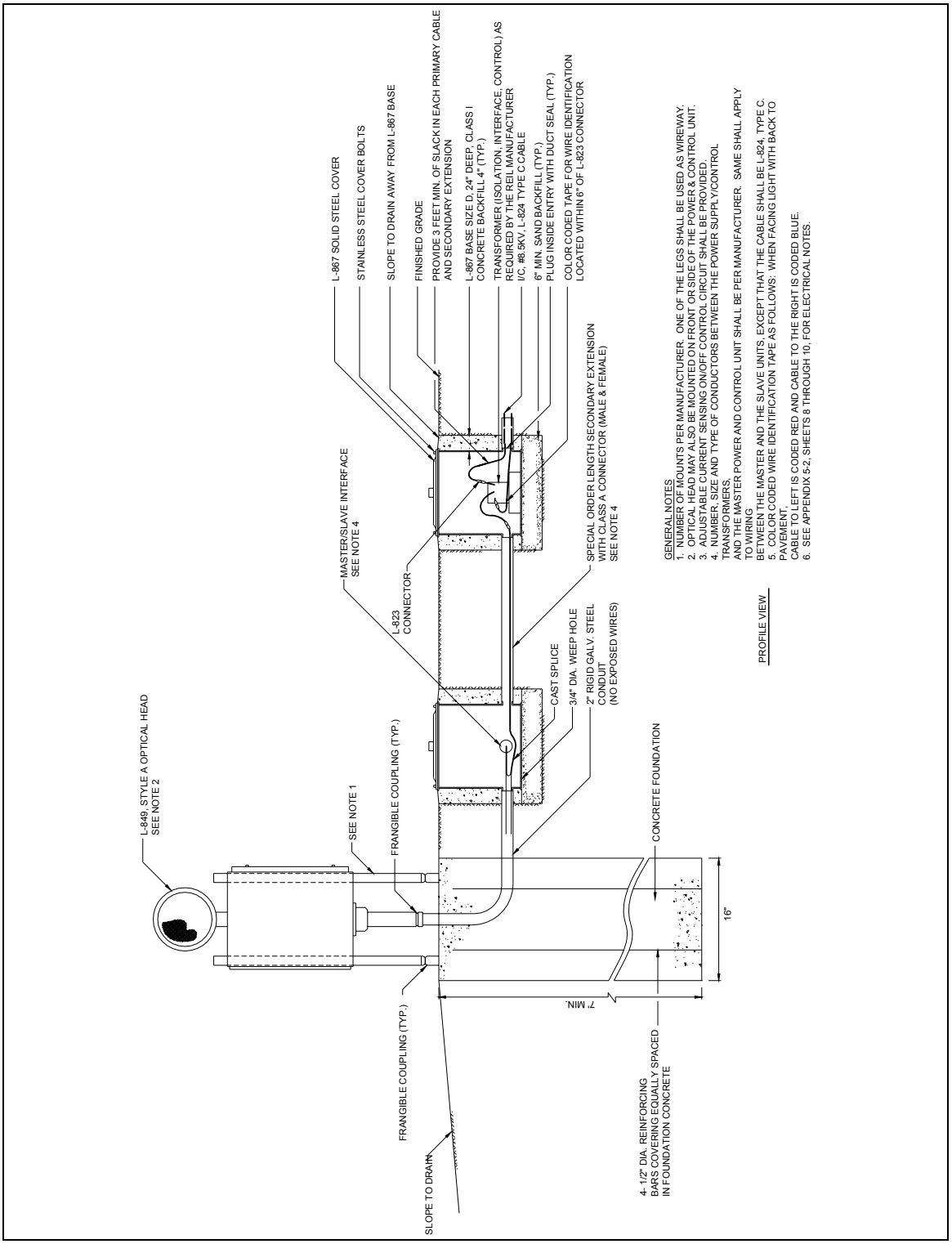

Figure 142 Standard Details for Runway End Identifier Light Power & Control Derived From Runway Circuit – GL-600 Sheet 7A – Profile View

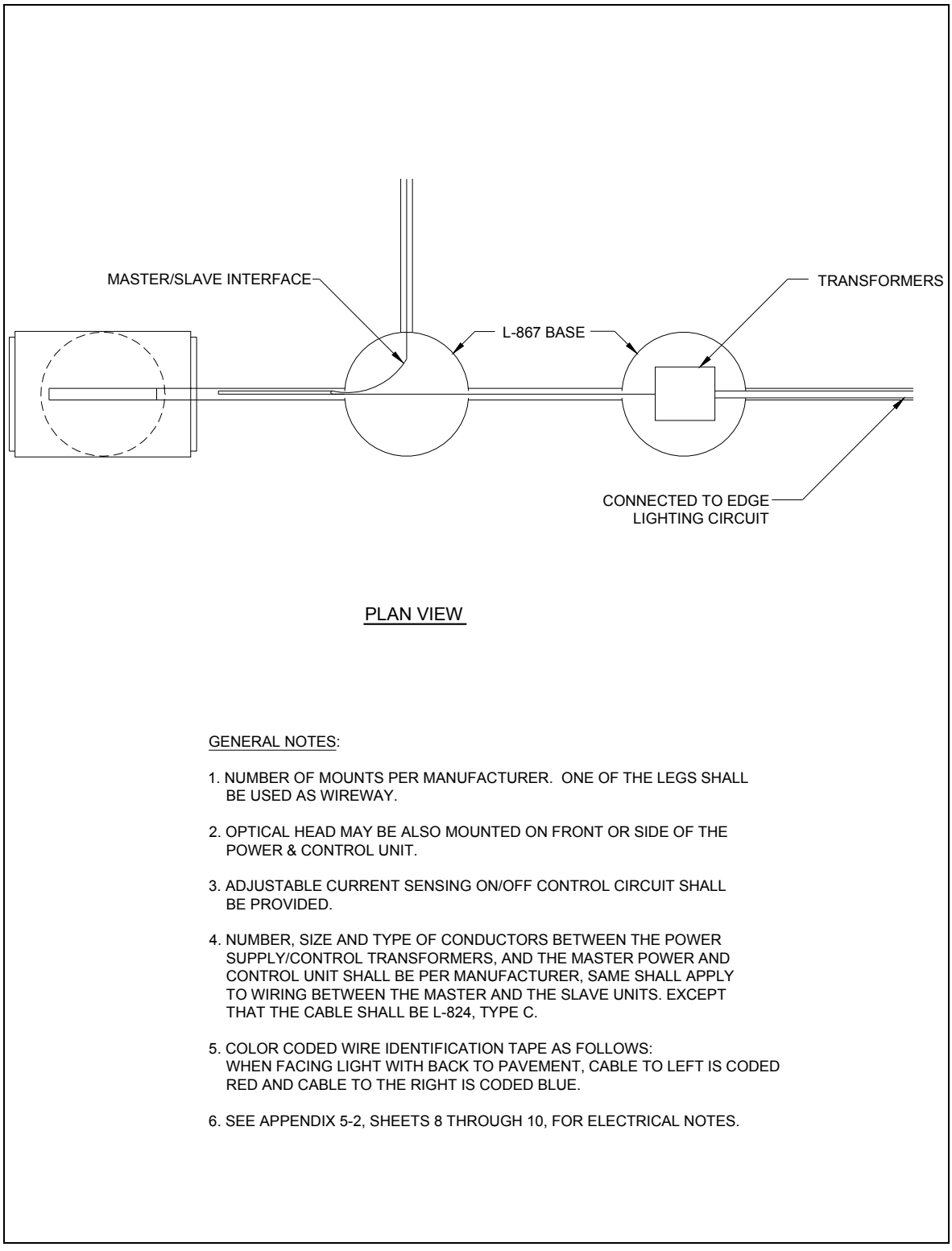

Figure 143 Standard Details for Runway End Identifier Light Power & Control Derived From Runway Circuit – GL-600 Sheet 7B – Plan View

A5-2. Electrical Notes

A5-2.1 Sheet 8

a. General

(1) The electrical installation, as a minimum, shall meet the NEC and local regulations.

(2) The contractor shall ascertain that all lighting system components furnished by him (included FAA approved equipment) are compatible in all respects with each other and the remainder of the new/existing system. Any non-compatible components furnished by this contractor shall be replaced by the contractor at no additional cost to the airport sponsor with a similar unit, approved by the engineer (different model or different manufacturer), that is compatible with the remainder of the airport lighting system.

(3) In case the contractor selects to furnish and install airport lighting equipment requiring additional wiring, transformers, adapters, mountings, etc., to those shown on the drawings and/or listed in the specifications, any cost for these items shall be incidental to the equipment cost.

(4) The contractor-installed equipment (including FAA approved) shall not generate any electromagnetic interference in the existing and/or new communications, weather, air navigation, and air traffic control equipment. Any equipment generating such interference shall be replaced by the contractor at no additional cost with equipment meeting the applicable specifications and not generating any interference.

(5) When a specific type, style, class, etc., of FAA approved equipment is specified only that type, style, class, etc., will be acceptable, even though equipment of other types, style, class, etc., may be FAA approved.

(6) Any and all instructions from the engineer to the contractor regarding changes in, or deviations from, the plans and specifications shall be in writing with copies sent to the airport sponsor and the FAA field office (ADO/AFO). The contractor shall not accept any verbal instructions from the engineer regarding any changes from the plans and specifications.

(7) A minimum of three copies of instruction book shall be supplied with each different type of equipment. The books describing a more sophisticated type of equipment, such as regulators, PAPI, REIL, etc., at a minimum shall contain the following:

(a) A detailed description of the overall equipment and its individual components.

(b) Theory of operation including the function of each component.

(c) Installation instructions.

(d) Start-up instructions.

(e) Preventative maintenance requirements.

(f) Chart for troubleshooting.

(g) Complete power and control detailed wiring diagram(s), showing each conductor/connection/component "black" boxes are not acceptable. The diagram or the

narrative shall show voltages/currents/wave shapes at strategic locations to be used when checking and/or troubleshooting the equipment. When the equipment has several brightness steps, these parameters shall be indicated for all the different modes.

(h) Parts list will include all major and minor components, such as resistors, diodes, etc. It shall include a complete nomenclature of each component and, if applicable, the name of its manufacturer and the catalog number.

(i) Safety instructions.

b. Power and control

(1) Stencil all electrical equipment to identify function, circuit voltage and phase. Where the equipment contains fuses, also stencil the fuse or fuse link ampere rating. Where the equipment does not have sufficient stenciling area, the stenciling shall be done on the wall next to the unit. The letters shall be one inch high and painted in white or black paint to provide the highest contrast with the background.

(2) Color code all phase wiring by the use of colored wire insulation and/or colored tape. Where tape is used, the wire insulation shall be black. Black and red shall be used for single-phase, three wire systems and black, red and blue shall be used for three-phase systems. Neutral conductors, size no. 6 AWG or smaller, shall be identified by a continuous white or natural conductors larger than no. 6 AWG shall be identified either by a continuous white or natural gray outer finish along its entire length or by the use of white tape at its terminations and inside accessible wireways.

(3) All branch circuit conductors connected to a particular phase shall be identified with the same color. The color coding shall extended to the point of utilization.

(4) In control wiring the same color shall be used throughout the system for the same function, such as 10%, 30%, 100% brightness control, etc.

(5) All power and control circuit conductors shall be copper; aluminum shall not be accepted. This includes wire, cable, busses, terminals, switch/panel components, etc.

(6) Low voltage (600 v.) and high voltage (5000 v.) conductors shall be installed in separate wireways.

(7) Neatly lace wiring in distribution panels, wireways, switches and pull/junction boxes.

(8) The minimum size of pull/junction boxes, regardless of the quantity and the size of the conductors shown, shall be as follows:

(a) In straight pulls the length of the box shall not be less than eight times the trade diameter of the larger conduit. The total area (including the conduit cross-sectional area) of a box end shall be at least 3 times greater than the total trade cross-sectional area of the conduits terminating at the end.

(b) In angle or u-pulls the distance between each conduit entry inside the box and the opposite wall of the box shall not be less than six times the trade diameter of the largest conduit. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other conduit entries on the same wall of the box. The distance between conduit entries enclosing the same conductor shall of not be less than six times the trade diameter of the largest conduit.

(9) A run of conduit between terminations at equipment enclosures, square ducts and pull/junction boxes, shall not contain more than the equivalent of four quarter bends (360 degrees total), including those bends located immediately at the terminations. Cast, conduit type outlets shall not be treated as pull/junction boxes.

(10) Equipment cabinets shall not be used as pull/junction boxes. Only wiring terminating at the equipment shall be brought into these enclosures.

(11) Splices and junction points shall be permitted only in junction boxes, ducts equipped with removable covers, and at easily accessible locations.

(12) Circuit breakers in power distribution panel(s) shall be thermal-magnetic, molded case, permanent trip with 100 ampere, minimum, frame.

(13) Dual lugs shall be used where two wires, size no. 6 or larger, are to be connected to the same terminal.

(14) All wall mounted equipment enclosures shall be mounted on wooden mounting boards.

(15) Wooden equipment mounting boards shall be plywood, exterior type, 3/4 inch minimum thickness, both sides painted with one coat of primer and two coats of gray, oil-based paint.

(16) Rigid steel conduit shall be used throughout the installation unless otherwise specified. The minimum trade size shall be 3/4 inch.

(17) All rigid conduit shall be terminated at constant current regulators with a section (10" minimum) of flexible conduit.

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(18) Unless otherwise shown all exposed conduits shall be run parallel to, or at right angles with, the lines of the structure.

(19) All steel conduits, fittings, nuts, bolts, etc., shall be galvanized.

(20) Use conduit bushings at each conduit termination. Where no. 4 AWG or larger ungrounded wire is installed, use insulated bushings.

(21) Use double lock nuts at each conduit termination.

(22) Wrap all primary and secondary power transformer connections with sufficient layers of insulating tape and cover with insulating varnish for full value of cable insulation voltage.

(23) Unless otherwise noted, all indoor single conductor control wiring shall be no. 12 AWG.

(24) Both ends of each control conductor shall be terminated at a terminal block. The terminal block shall be of proper rating and size for the function intended and they shall be located in equipment enclosures or special terminal cabinets.

(25) All control conductor terminators shall be of the open-eye connector/screw type. Soldered, closed-eyed terminators, or terminators without connectors are not acceptable.

(26) In terminal block cabinets the minimum spacing between parallel terminal blocks shall be 6 inches. The minimum spacing between terminal block sides/ends and cabinet sides/bottom/top shall be 5 inches. The minimum spacing will be increased as required by the number of conductors. Additional spacing shall be provided at conductor entrances.

(27) Both ends of all control conductors shall be identified as to the circuit, terminal, block, and terminal number. Only stick-on labels shall be used.

(28) A separate and continuous neutral conductor shall be installed and connected for each breaker circuit in the power panel(s) from the neutral bar to each power/control circuit.

(29) The following shall apply to relay/contractor panel/enclosures:

(a) All components shall be mounted in dust proof enclosures with vertically hinged covers.

(b) The enclosures shall have ample space for the circuit components, terminal blocks, and incoming internal wiring.

(c) All incoming/outgoing wiring shall be terminated at terminal blocks.

(d) Each terminal on terminal blocks and on circuit components shall be clearly identified.

(e) All control conductor terminations shall be of the open-eye connector/screw type. Soldered, closed-eye connectors, or terminations without connectors are not acceptable.

(f) When the enclosure cover is opened, all circuit components, wiring, and terminals shall be exposed and accessible without any removal of any panels, covers, etc., except those covering high voltage components.

(g) Access to, or removal of, a circuit component or terminal block will not require the removal of any other circuit component or terminal block.

(h) Each circuit component shall be clearly identified indicating its corresponding number shown on the drawing and its function.

(i) A complete wiring diagram (not a schematic diagram) shall be mounted on the inside of the cover. The diagram shall represent each conductor by a separate line.

(j) The diagram shall identify each circuit component and numbering and color of each internal conductor and terminal.

(k) All wiring shall be neatly trained and laced.

(l) Minimum wire size shall be no. 12 AWG.

c. Field lighting

(1) Unless otherwise notified all underground field power multiple and series circuit conductors whether direct earth burial (DEB) or in duct/conduit shall be FAA approved L-824 type. Insulation voltage and size shall be as specified.

(2) No components of primary circuit such as cable, connectors and transformers shall be brought above ground at edge lights, signs, REIL, etc.

(3) There shall be no exposed power/control cables between the point where they leave the underground (DEB or L-867 bases) and where they enter the equipment (such as taxiway signs, PAPI, REIL, etc.). Enclosures. These cables shall be enclosed in rigid conduit or in flexible water-tight conduit with frangible coupling(s) at the grade or the housing cover, as shown in applicable details.

(4) The joints of the L-823 primary connectors shall be wrapped with one layer of rubber or synthetic rubber tape and one layer of plastic tape, one half lapped, extending at least 1-1/2 inches on each side of the joint, as shown in Figure 125.

(5) The cable entrance into the field attached L-823 connectors shall be enclosed by a heat-shrinkable tubing with continuous internal adhesive as shown in Figure 125.

(6) The ID of the primary L-823 field attached connectors shall match the cable ID to provide a watertight cable entrance. This entrance shall be encapsulated in a heat shrinkable tubing with continuous factory applied internal adhesive, as shown in Figure 125.

(7) L-823 type 11, two-conductor secondary connector shall be class "A" (factory molded).

(8) There shall be no splices in the secondary cable(s) within the stems of a runway/taxiway edge/threshold lighting fixtures and the wireways leading to taxiway signs and PAPI/REIL equipment.

(9) Electrical insulating grease shall be applied within the L-823, secondary, two conductor connectors to prevent water entrance. These connectors shall not be taped.

(10) Deb isolation transformers shall be buried at a depth of 10 inches on a line crossing the light and perpendicular to the runway/taxiway centerline at a location 12 inches from the light opposite from the runway/taxiway.

(11) Deb primary connectors shall be buried at a depth of 10 inches near the isolation transformer. They shall be orientated parallel with the runway/taxiway centerline. There shall be no bends in the primary cable 6 inches, minimum, from the entrance into the field-attached primary connection.

(12) A slack of 3 feet, minimum, shall be provided in the primary cable at each transformer/connector termination. At stake mounted lights the slack shall be loosely coiled immediately below the isolation transformer.

(13) Direction of primary cables shall be identified by color coding as follows, when facing light with back facing pavement, cable to the left is coded red and cable to the right is coded blue, this applies to the stake mounted lights and base mounted lights where the base has only one entrance.

(14) L-867 bases shall be size b, 24" deep class 1 unless otherwise noted.

(15) Base mounted frangible couplings shall not have weep holes to the outside. Plugged up holes shall not be acceptable. It shall have a 1/4" diameter minimum or equivalent opening for drainage from the space around the secondary connector into the L-867 base.

(16) The elevation of the frangible coupling groove shall not exceed 1-1/2" above the edge of the cover in case of base mounted couplings, or the top of the stake in case of stake mounted couplings.

(17) Where the frangible coupling is not an integral part of the light fixture stem or mounting leg, a bead of silicon seal shall be applied completely around the light stem or wireway at frangible coupling to provide a watertight seal.

(18) Tops of the stakes supporting light fixtures shall be flush with the surrounding grade.

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(19) Plastic lighting fixture components, such as lamp heads, stems, frangible couplings, base covers, brackets, stakes, shall not be acceptable. L-867 plastic transformer housings are acceptable. The metal threaded fitting shall be set in flange during casting process. Base cover bolts shall be fabricated from 18-8 stainless steel.

(20) The tolerance for the height of runway/taxiway edge lights shall be ± one (1) inch. In case of stake mounted lights, the specified lighting fixture height shall be measured between the top of the stake and the top of the lens. In case of base mounted lights. The specified lighting fixture height shall be measured between the top of the base flange and the top of the lens, thus including the base cover. The frangible coupling, the stem, the lamp housing and the lens.

(21) The tolerance for the lateral spacing (light lane to runway/taxiway centerline) of runway/taxiway edge lights shall be ± one (1) inch. This also applies at intersections to lateral spacing between lights of a runway/taxiway and the intersecting runway/taxiway.

(22) Soil permitting the L-867 bases shall not be pre-cast in concrete. Concrete around the bases shall be used as a backfill.

(23) Entrances into L-867 bases shall be plugged from the inside with duct seal.

(24) Galvanized/painted equipment/component surfaces shall not be damaged by drilling, filing, etc. Drain holes in metal transformer housings shall be made before galvanized.

(25) Edge light numbering tags shall be facing the pavement.

(26) Cable/splice/duct markers shall be pre-cast concrete of the size shown. Letters/numbers/arrows for the legend to be impressed into the tops of the markers shall be pre-assembled and secured in the mold before the concrete is poured. Legend inscribed by hand in wet concrete shall not be acceptable.

(27) All underground cable runs shall be identified by cable markers at 200 feet maximum spacing, with an additional marker at each change of direction of the cable run. Cable markers shall be installed immediately above the cable.

(28) Locations of all DEB underground cable splice/connections, except those at isolation transformers, shall be identified by splice markers. Splice markers shall be placed immediately above the splice/connections.

(29) The cable and splice markers shall identify the circuits which the cables belong to, such as RWY 4-22, PAPI-4, PAPI-22, etc.

(30) Locations of ends of all underground ducts shall be identified by duct markers.

(31) The preferred mounting method of runway and taxiway signs is by the use of single row of legs. However, two rows will be acceptable.

(32) The preferred method to bring the power cable into an L-858 sign is method A, as shown in Figure 129, however, method B is also acceptable.

(33) Stencil horizontal and vertical aiming angles on each REIL flash head or equipment enclosure. The numerals shall be black and one inch minimum height.

(34) Stencil vertical aiming angles on the outside of each PAPI lamp housing. The numerals shall be black and one inch minimum height.

(35) All power and control cables in man/hand holes shall be tagged. Use embossed copper strips attached at both ends to the cable by the use of plastic straps. Minimum of two tags shall be provided on each cable in a man/hand hole - one at the cable entrance and one at the cable exit.

(36) Apply an oxide inhibiting, anti-seizing compound to all screws, nuts and frangible coupling threads.

(37) There shall be no splices between the isolation transformers. L-823 connectors are allowed at transformer connections only, unless otherwise shown.

(38) Deb splices in home runs shall be of the cast type, unless otherwise shown.

(39) Where a parallel, constant voltage PAPI system is provided, the "T" splices shall be of the cast type.

(40) Concrete used for slabs, footing, backfill around transformer housings, markers, etc., shall be 3000 PSI, min., air-entrained.

d. Grounding

(1) Ground all non-current-carrying metal parts of electrical equipment by using no. 6 AWG bare copper wire to be run inside cabinets and in conduits together with other wires. Where this is not feasible, run the exposed grounding wire parallel or at right angles to the building line and secure it at least every 24 inches and within 6 inches from bend or junction. The exposed wire may be no. 6 AWG if it is not subjected to physical abuse, otherwise no. 4 AWG shall be used.

(2) All ground connections to ground rods, busses, panels, etc., shall be made with pressure type solderless lugs and ground clamps. Soldered or bolt and washer type connections are not acceptable. Clean all metal surfaces before making ground connections.

(3) Tops of ground rods shall be 10 inches below grade.

(4) The resistance to ground of the vault grounding system with the commercial power line neutral disconnected shall not exceed 10 ohms.

(5) The resistance to ground of the counterpoise system, or at isolation locations, such as airport beacon shall not exceed 25 ohms.